The Immediate Effect of Sham Laser and Three Different Spinal Manipulative Protocols on Kicking Speed in Soccer Players

By

Kyle Colin Deutschmann

Dissertation submitted in partial compliance with the requirements for the Master's degree in Technology: Chiropractic

Durban University of Technology

I, Kyle Colin Deutschmann, do declare that this dissertation is a representation of my own work in both concept and execution.

________________ *Date:* ____________

Kyle Colin Deutschmann

Approved for examination:

________________ *Date:* ____________

Dr. A. Jones [M. Dip. C; M. Med. Sci (Sports Medicine)]

DEDICATION

To my Hero, Saviour and Friend Jesus Christ. This dedication just gives me another excuse to thank you for all you have done for my family and me. Thank you for transforming us and please continue to do so, from one state of glory to the next! Your favour in our lives has not gone unnoticed.

To my family, words cannot give justice to the thankfulness due to you. Thank you for your unending provision, love and kindness. Please, don’t stop. Thank you for following and loving your Jesus with all you have. You truly are amazing examples.

ACKNOWLEDGEMENTS

A big thank you goes out to my family: my dad, Bobby, my mom, Phyllis and my brother, Luke. This all would not have been possible without your continual support and encouragement.

To my supervisor, Dr A. Jones, thank you for all your enthusiasm and determination, as well as all the guidance you have given me to get me through the research process. You truly have inspired me to be a great Chiropractor, because of your wonderful teaching skills and down to earth nature.

To Dr K. Sood, thank you for giving up a lot of your spare time to supervise this research when it was performed off-campus.

To all the staff and management at the Highway Action Arena, thank you for letting me utilize your facilities during this research process and the kind hospitality that was displayed towards me.

Thank you, to all the subjects that volunteered their free time.

To the head of department, Dr C. Korporaal, thank you for all the inspiration you have given to me and all the knowledge you have shared with me and the rest of my classmates. The profession of Chiropractic would not be where it is now without you. Your humility is something I admire.

Thank you to all the staff at the D.U.T campus who have a significant impact in some sort of way during my six years of varsity life, I am truly grateful for what you have all shared with me.

To all my classmates, thank you for making the last six years go quicker than I could have ever imagined, all the laughs we shared and the tears we cried. All the best for the future and I know everyone of you will be successful. Sparta will never fall. We ride together, we die together.

ABSTRACT

Background:

In terms of kicking speed the instep kicking technique is the most effective and commonly used method. Immobilization or restricted motion within a joint segment, results in adverse changes in the surrounding ligaments, tendons and muscular tissue. To improve joint mobility and thus improving flexibility, this study focused on spinal manipulation.

Objectives:

The main purpose of this study was to determine the immediate effectiveness of lumbar spine and sacroiliac manipulation on the range of motion (ROM) of the lumbar spine and sacroiliac joints as well as the kicking speed of the subjects.

Methods:

Forty asymptomatic soccer players, playing for the regional Premier League team or higher, were divided into four groups of 10 each. Group 1 received lumbar spine manipulation, Group 2 received sacroiliac (SI) joint manipulation, Group 3 received combined lumbar spine and SI joint manipulation and Group 4 received the sham laser intervention (placebo/control). Pre and post warm-up and post intervention lumbar and SI joint ROM were measured using a digital inclinometer. Kicking speed was measured post warm-up and post intervention with a Speed Trac™ Speed Sport Radar. The subjects' perception of a change in kicking speed post intervention was also recorded. SPSS version 15.0 was used to analyse the data.

Results:

Pre and post outcome measurements were compared using a p value of < 0.05 to indicate statistical significance. Statistically significant ROM increases were noticed in left and right lumbar rotation motions post lumbar manipulative intervention. Lumbar extension, left and right lumbar rotation and SI joint extension ROM increased post combination of lumbar spine and SI joint manipulation. There

was a significant increase in kicking speed post intervention for all three manipulative intervention groups. A significant correlation was seen between subjects' perception of change in kicking speed post intervention and the objective results obtained.

Conclusions:

Lumbar spine and SI joint manipulation is an effective intervention for short-term increase in kicking speed.

TABLE OF CONTENTS

DEDICATION **II**

ACKNOWLEDGEMENTS **III**

ABSTRACT **V**

TABLE OF CONTENTS **VII**

LIST OF APPENDICES **XIII**

LIST OF TABLES **XIV**

LIST OF FIGURES **XV**

LIST OF DEFINITIONS **XVII**

LIST OF ABBREVIATIONS **XVIII**

CHAPTER 1 **1**

INTRODUCTION

1.1 INTODUCTION TO THE STUDY **1**

1.2 AIMS AND OBJECTIVES OF THE STUDY **3**

1.3 HYPOTHESES OF THE STUDY **3**

1.4 SCOPE OF THE STUDY **3**

CHAPTER 2 **4**

LITERATURE REVIEW

2.1 INTRODUCTION **4**

2.2 AN OVERVIEW OF THE GAME OF SOCCER **5**

2.3 KICKING IN SOCCER **7**

2.3.1 Types of Kicking Action

2.3.2 Biomechanics of the Instep Kicking Action

2.3.3 Kicking Speed

2.4 AN OVERVIEW OF THE BONY ANATOMY OF THE LUMBAR SPINE AND THE SACROILIAC JOINT AND THEIR ROM **13**

2.4.1 Lumbar Spine

2.4.2 Sacroiliac Joint

2.5 THE ROLE OF THE LUMBAR SPINE AND SI JOINTS IN THE INSTEP KICKING TECHNIQUE **16**

2.6 MOTION PALPATION, SPINAL MANIPUATION AND ROM **18**

2.7 HAWTHORNE AND PLACEBO EFFECTS **19**

2.7.1 The Hawthorne Effect

2.7.2 The Placebo Effect

2.7.3 Similarities and Differences between the Hawthorne and Placebo Effects

2.8 CONCLUSION **21**

CHAPTER 3 **23**

METHODOLOGY

3.1 STUDY DESIGN **23**

3.2 ADVERTISING **23**

3.3 SAMPLE SIZE AND SELECTION **23**

3.4 THE CONSULTATION **23**

3.4.1 Inclusion Criteria

3.4.2 Exclusion Criteria

3.4.3 Subject Informed Consent

3.4.4 Group Allocation

3.4.5 Procedure

3.4.5.1 The Kick

3.4.5.2 The Manipulative Technique

3.4.5.3 The Need for the Control Group

3.5 THE OUTCOME MEASURES **27**

3.6 MEASUREMENT TOOLS **28**

3.6.1 Saunders Digital Inclinometer

3.6.1.1 Assessment of the Lumbar and Sacroiliac ROM

3.6.2 Speed Trac™ Speed Sport Radar

3.6.3 Subjects' Perception of Kicking Speed

3.7 ETHICAL CONSIDERATIONS IN THE STUDY **31**

3.8 STATISTICAL ANALYSIS **32**

CHAPTER 4 **33**

RESULTS

4.1 INTRODUCTION **33**

4.2 TOOLS USED IN OBTAINING DATA **33**

4.3 PHYSICAL CHARACTERISTIC AND DEMOGRAPHIC DATA **35**

4.4 REVIEW OF OBJECTIVES **35**

4.4.1 Objective One

4.4.1.1 Range of Motion Findings for Group 1

4.4.1.2 Kicking Speed Finding for Group 1

4.4.2 Objective Two

4.4.2.1 Range of Motion Findings for Group 2

4.4.2.2 Kicking Speed Finding for Group 2

4.4.3 Objective Three

4.4.3.1 Range of Motion Findings for Group 3

4.4.3.2 Kicking Speed Finding for Group 3

4.4.4 Objective Four

4.4.4.1 Range of Motion Findings for Group 4

4.4.4.2 Kicking Speed Finding for Group 4

4.4.5 Objective Five

4.4.5.1 Lumbar Flexion

4.4.5.2 Lumbar Extension

4.4.5.3 Left Lumbar Lateral Flexion

4.4.5.4 Right Lumbar Lateral Flexion

4.4.5.5 Left Lumbar Rotation

4.4.5.6 Right Lumbar Rotation

4.4.5.7 Left SI Flexion Measurement 1

4.4.5.8 Left SI Flexion Measurement 2

4.4.5.9 Right SI Flexion Measurement 1

4.4.5.10 Right SI Flexion Measurement 2

4.4.5.11 Average Kicking Speed

4.4.5.12 Maximum Kicking Speed

4.4.6 Objective Six

CHAPTER 5 **64**

DISCUSSION

5.1 INTRODUCTION **64**

5.2 DEMOGRAPHIC DATA AND PHYSICAL CHARACTERISTICS **64**

5.3 ROM FINDINGS **65**

5.3.1 Discussion on the ROM Findings Post Intervention for Groups 1, 2 and 3

5.3.2 Discussion on the ROM Findings Post Sham Laser Intervention for Group 4

5.3.3 Summary

5.4 LUMBAR SPINE ROM DISCUSSION **69**

5.4.1 Inter-group Discussion on the Findings of Lumbar Flexion

5.4.2 Inter-group Discussion on the Findings of Lumbar Extension

5.4.3 Inter-group Discussion on the Findings of Lumbar Lateral Flexion (Left and Right)

5.4.4 Inter-group Discussion on the Findings of Lumbar Rotation (Left and Right)

5.4.5 Summary

5.5 SACROILIAC JOINT ROM DISCUSSION **71**

5.5.1 Inter-group Discussion for Left and Right SI Flexion (Measurement 1)

5.5.2 Inter-group Discussion for Left and Right SI Flexion (Measurement 2)

5.5.3 Summary

5.6 KICKING SPEED FINDINGS **72**

5.6.1 Discussion on the Kicking Speed Findings Post Intervention for Groups 1, 2 and 3

5.6.2 Discussion on the Kicking Speed Findings Post Sham Laser Intervention for Group 4

5.6.3 Summary

5. 7 DISCUSSION ON AVERAGE AND MAXIMUM KICKING SPEED **76**

5.8 SUBJECTS PERCEPTION OF THE CHANGE IN KICKING SPEED **76**

CHAPTER 6 **78**

RECOMMENDATIONS

6.1 CONCLUSION **78**

6.2 RECOMMENDATIONS **80**

REFERENCES **83**

APPENDICES **90**

LIST OF APPENDICES

Appendix A : Letters of Information and Consent

Appendix B : Advertisement

Appendix C : Case history

Appendix D : Physical Examination

Appendix E : Regional Examination of the Lumbar Spine and Pelvis

Appendix F : SOAPE

Appendix G : Subjects' Perception of Change in Kicking Speed

Appendix H : Warm-up Routine

Appendix I : Statistician Agreement

Appendix J : Highway Action Arena Letter

Appendix K : Letter from Dr Sood

Appendix L : Sacroiliac Results from Group 1

Appendix M : Lumbar ROM Results from Group 2

Appendix N : Ethics clearance certificate

Appendix O : Data Readings

LIST OF TABLES

CHAPTER 2

Table 2.1: Muscular Action During Kicking Preparation (right footed kick) **8**

Table 2.2: Muscular Action During Follow-Through (right footed kick) **11**

Table 2.3: Balls Speeds (m/s) as Reported by the Literature **12**

CHAPTER 4

Table 4.1: Comparison of Demographics by Group **35**

Table 4.2: Range of Motion **35**

Table 4.3: Kicking Speed **38**

Table 4.4: Range of Motion **39**

Table 4.5: Kicking Speed **41**

Table 4.6: Range of Motion **42**

Table 4.7: Kicking Speed **45**

Table 4.8: Range of Motion **46**

Table 4.9: Kicking Speed **48**

Table 4.10: Inter-group Lumbar Flexion Comparison **49**

Table 4.11: Inter-group Lumbar Extension Comparison **50**

Table 4.12: Inter-group Lumbar Left Lateral Flexion Comparison **51**

Table 4.13: Inter-group Lumbar Right Lateral Flexion Comparison **52**

Table 4.14: Inter-group Lumbar Left Rotation Comparison **53**

Table 4.15: Inter-group Lumbar Right Rotation Comparison **54**

Table 4.16: Inter-group Left SI Flexion 1 Comparison **55**

Table 4.17: Inter-group Left SI Flexion 2 Comparison **56**

Table 4.18: Inter-group Right Flexion 1 Comparison **57**

Table 4.19: Inter-group Right Flexion 2 Comparison **58**

Table 4.20: Inter-group Average Kicking Speed Comparison **59**

Table 4.21: Inter-group Maximum Kicking Speed Comparison **60**

Table 4.22: Cross Tabulation of Subjective Change and Objective Change in Average Kicking Speed **62**

Table 4.23: Cross Tabulation of Subjective Change and Objective Change in Maximum Kicking Speed **62**

LIST OF FIGURES

CHAPTER 2

Figure 2.1: Diagram of the Soccer Field with Dimensions **6**

Figure 2.2: Diagram of Soccer Post with Dimensions **6**

Figure 2.3: Illustration of the Body Position During the Kicking Action **10**

Figure 2.4: Labelled Diagram of a Lumbar Vertebra **14**

Figure 2.5: Diagram Illustrating the Sacroiliac Joint **15**

CHAPTER 3

Figure 3.1: Set-up of the Speed Trac™ Speed Sport Radar at the Action Arena **30**

CHAPTER 4

Figure 4.1: Flow Diagram Showing Subject Intake and Group Allocation **34**

Figure 4.2: Results of ROM changes in Group 1 **37**

Figure 4.3: Graphs Showing the Kicking Speeds of Subjects in Group 1 Pre and Post Intervention **38**

Figure 4.4: Results of ROM Changes in Group 2 **40**

Figure 4.5: Graphs Showing the Kicking Speeds of Subjects in Group 2 Pre and Post Intervention **41**

Figure 4.6: Results of ROM Changes in Group 3 **43**

Figure 4.7: Graphs Showing the Kicking Speeds of Subjects in Group 3 Pre and Post Intervention **45**

Figure 4.8: Results of ROM Changes in Group 4 **47**

Figure 4.9: Graphs Showing the Kicking Speeds of Subjects in Group 4 Pre and Post Intervention **49**

Figure 4.10: Graphs Showing Inter-group Lumbar Flexion Comparison **50**

Figure 4.11: Graph Showing Inter-group Lumbar Extension Comparison **51**

Figure 4.12: Graph Showing Inter-group Lumbar Left Lateral Flexion Comparison **52**

Figure 4.13: Graph Showing Inter-group Lumbar Right Lateral Flexion Comparison **53**

Figure 4.14: Graph Showing Inter-group Left Lumbar Rotation Comparison **54**

Figure 4.15: Graph Showing Inter-group Right Lumbar Rotation Comparison **55**

Figure 4.16: Graph Showing Inter-group Left SI Flexion 1 Comparison **56**

Figure 4.17: Graph Showing Inter-group Left SI Flexion 2 Comparison **57**

Figure 4.18: Graph Showing Inter-group Right SI Flexion 1 Comparison **58**

Figure 4.19: Graph Showing Inter-group Right Flexion 2 Comparison **59**

Figure 4.20: Graph Showing Inter-group Average Kicking Speed Comparison **60**

Figure 4.21: Graph Showing Inter-Group Maximum Kicking Speed Comparison **61**

LIST OF DEFINITIONS

Asymptomatic For the purpose of this study, the term asymptomatic referred to subjects who were negative for any pain or discomfort.

Immediate Immediate can be interpreted in many ways with regards to the biomechanical functioning of the body and its response to treatment. For the purpose of this study, the definition as proposed by Gross *et al*., (2010) was utilized, viz the time frame between 0-10 minutes after intervention.

Elite Term given to describe players that are well trained and highly proficient at the sport.

LIST OF ABBREVIATIONS

Avg	**:**	Average
CONTD	**:**	Continued
km/h	**:**	Kilometres per hour
Lat Flex	**:**	Lateral flexion
Max	**:**	Maximum
m/s	**:**	meters per second
N	**:**	Sample size
N/A	**:**	Not Applicable
p	**:**	Probability
ROM	**:**	Range of motion
S.D	**:**	Standard deviation
SI	**:**	Sacroiliac

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION TO THE STUDY

In soccer, the instep kicking technique is the most effective and commonly used kicking technique in terms of kicking speed (Ingley and Harris, 2001). The open biomechanical nature of this kicking technique requires that all the power is generated by the muscles and the motion of the joints involved (Lees, 1996; Lees and Nolan, 1998). Immobilization, or restricted motion within a joint segment, results in adverse changes in the surrounding ligaments, tendons, muscular tissue and vascular elements (Gatterman, 1995 and 2003). Functional implications of these changes are as follows: loss of tensile strength, adhesions, loss of flexibility and range of motion (ROM), and muscle atrophy leading to a loss of functional ability (Redwood, 2003; Lederman, 2005). To improve joint mobility and thus improving flexibility, this study focused on spinal manipulation. This is because it has been shown to be a safe and effective way of increasing spinal joint mobility (Herzog, 2000; Gatterman *et al*., 2001; Gatterman, 2003).

1.2 AIMS AND OBJECTIVES OF THE STUDY

The aims of this study were:

1. To determine via a controlled, prospective, clinical trial the relative effectiveness of manipulation and sham laser intervention of the lumbar spine and sacroiliac joint regions, on kicking speed in asymptomatic soccer players.

Several specific objectives were identified and these included:

Objective One

To determine the immediate effect (pre and post intervention) of lumbar spine manipulation on the lumbar ROM and the kicking speed in soccer players, in terms of the subjective (related to kicking speed only) and objective measurements.

Objective Two

To determine the immediate effect (pre and post intervention) of sacroiliac joint manipulation on the sacroiliac ROM and the kicking speed in soccer players, in terms of the subjective and objective measurements.

Objective Three

To determine the immediate effect (pre and post intervention) of a combination of lumbar spine and sacroiliac joint manipulation on the lumbar spine and sacroiliac joint ROM and the kicking speed in soccer players, in terms of the subjective and objective measurements.

Objective Four

To determine the immediate effect (pre and post intervention) of sham laser technique on the lumbar spine and sacroiliac joint ROM and the kicking speed in soccer players, in terms of the subjective and objective measurements.

Objective Five

To compare the subjective and objective measures for all groups.

Objective Six

To determine the association between the change in kicking speed pre and post intervention and the subjects' perception of the change in kicking speed.

1.3 HYPOTHESES OF THE STUDY

For the objectives, the Null Hypotheses (Ho) were set as follows:

- There would be no statistically significant increases in kicking speed post intervention for any of the four groups.
- There would be no statistically significant increases in ROM for any of the four groups.
- There would be no statistically significant correlation between change in kicking speed immediately post intervention and change in ROM of the lumbar spine and / or the sacroiliac joint.
- There would be no statistically significant association between change in kicking speeds immediately post intervention and the subjects' perception of change in kicking speed.

1.4 SCOPE OF THE STUDY

The results of 40 soccer players, who were asymptomatic for clinical musculoskeletal symptoms, and who met all the inclusion criteria of the study are presented in this dissertation. The subjects were divided into four equal groups of ten. Group 1 received lumbar spine manipulation, Group 2 received the sacroiliac joint manipulation, Group 3 received a combined lumbar spine and sacroiliac joint manipulation and Group 4 received the sham laser intervention. Objective measurements included ROM of the lumbar spine and sacroiliac joints and the kicking speed of each subject. ROM measurements of the lumbar spine and sacroiliac joints were performed pre and post warm-up routine and post intervention with the digital inclinometer. Kicking speed measurements were recorded pre and post intervention. The subjects' perception of their change in kicking speed post intervention was also recorded.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

According to Bir, Cassatta and Janda (1995), soccer, also known as football, with an estimate of 40 million amateur players, is considered as the most popular sport played worldwide. Soccer is played predominantly using the feet, however players may use any part of their body except for their arms and hands, to move the ball around the field. The goalkeeper is an exception to this, as he is allowed to handle the ball inside the eighteen yard box **(Figure 2.1)**. The aim of soccer is to propel the ball into the opposition’s goalposts (Bir *et al.*, 1995).

The fundamental concept of soccer is the kicking technique. The velocity and accuracy of kicking can be vital in the outcome of the game (Sterzing and Henning, 2007). In the literature, a successful kick is defined in terms of either its accuracy or velocity (Sterzing and Henning, 2007). For this reason the instep kick is the most popular kicking technique (Ingley and Harris, 2001). The velocity of the kick, amongst other factors, is determined mainly by the acceleration of the limb produced by the biomechanical chain (Subotnick, 1991; Subotnick, 1999). The parts of the biomechanical chain are the ankle, knee and hip, transmitting forces to the pelvis and lower spine (Lees and Nolan, 1998).

2.2 AN OVERVIEW OF THE GAME OF SOCCER

In the game of soccer, a match is played by two teams each consisting of eleven players, one of whom is the goalkeeper. The match may not begin if a team consists of less than seven players. There are 3 officials that control the game, a referee, and two assistant referees. The field is a rectangular grass surface, which may be artificial in some cases, and is between 100 and 130 yards long and 50 and 100 yards wide **(Figure 2.1)**. On each goal line stands a rectangular goal post, 7.32 meters wide and 2.44 meters high **(Figure 2.2)**. The rest of the field markings are as per **Figure 2.1** (Fifa, 2010).

The game is played in two equal halves of 45 minutes, with the teams entitled to a halftime break lasting no longer then 15 minutes. Extra time may be added on at the end of the second half and this is done at the discretion of the referee. Allowance is made for time lost through:

- Substitutions,
- Assessment of injury to players,
- Removal of injured players from the field of play for treatment and / or
- Time wasting.

Within this time the aim of the players is to score as many goals as possible. A goal is scored when the whole of the ball passes over the goal line, under the crossbar and between the goalposts, provided that the scoring team has not infringed on the laws of the game in any way prior to the ball crossing the line. When the referee blows the final whistle, the team with the most goals scored is the winner (Fifa, 2010).

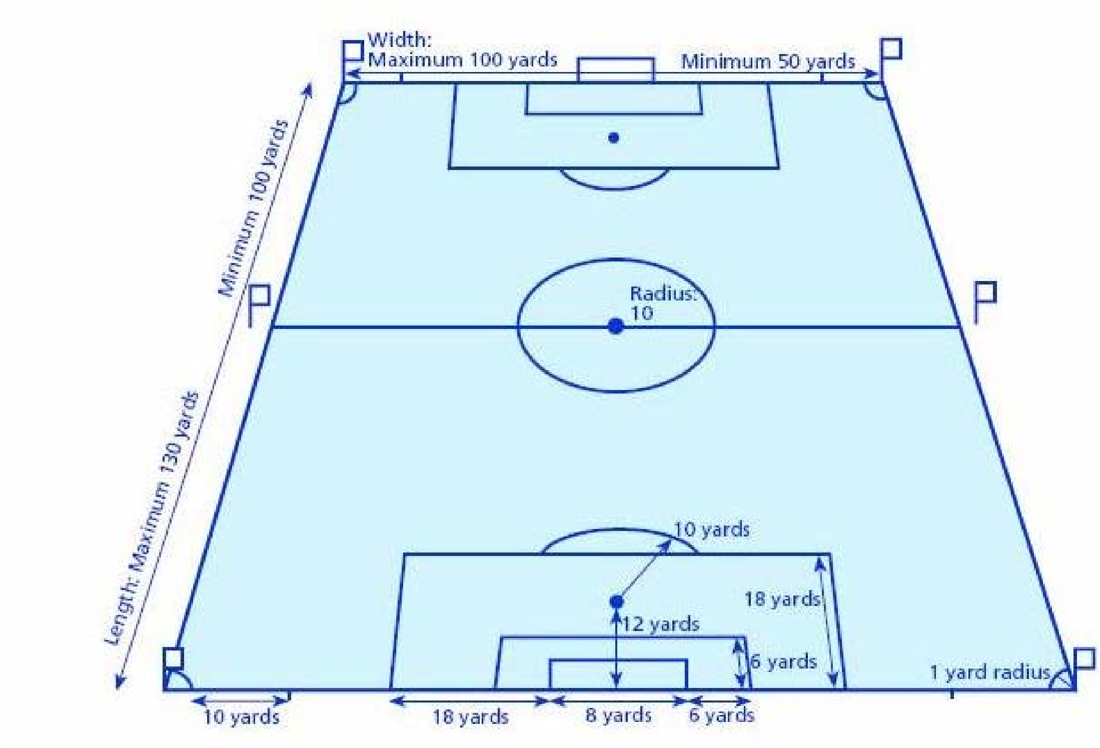


Figure 2.1 Diagram of the soccer field with dimensions (http://www.prosportsofficialteamsites.com/Soccer.html, 2007)

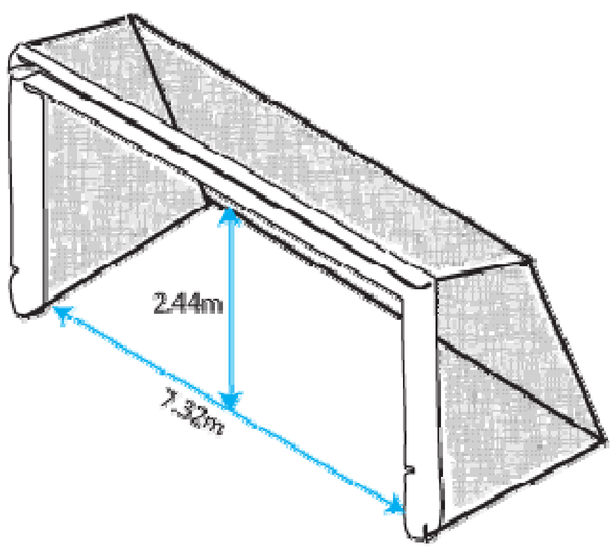


Figure 2.2 Diagram of the soccer posts with dimensions (http://www.dsr.wa.gov.au/soccerdimensions, 2011)

A soccer team divides their ten outfield players into defenders, midfielders, and strikers. Usually there are four defenders, four midfielders, and two strikers, but this does alter according to the coach's preferences and player availability.

2.3 KICKING IN SOCCER

2.3.1 Types of Kicking Actions

There are many different techniques used to kick the soccer ball from the ground, and these techniques are named according to the part of the foot that comes into contact with the ball at impact. Namely, the instep, side foot, outside foot, chip, instep curve and outside curve techniques. However, the majority of passes and shots performed during a soccer match are done using one of two techniques (Nunome, Georgakis, Shinkai, Suito, Tsujimoto and Ikegami. 2007; How to Strike the Ball, 2009):

- The instep kicking technique and / or
- The side foot kicking technique.

A successful kick is defined in terms of either the accuracy or velocity of the kick (Sterzing and Henning, 2007). The instep kicking technique is the most popular kicking technique and is used mainly in high velocity kicks such as shooting and long distance passing, whereas the side foot kicking technique is used more for short distance low velocity passing (Ingley and Harris, 2001; Nunome *et al.,* 2007; How to Strike the Ball, 2009).

2.3.2 Biomechanics of the Instep Kicking Action

The parts of the biomechanical chain involved in the instep kicking technique are: the ankle, knee and hip (Lees and Nolan, 1998). During the kicking movement, the leg functions as an open kinematic chain (Dørge, Bull Andersen, Sørensen and Simonsen, 2002).

Kicking is accepted as a segmented motion pattern sequence which operates from the proximal-to-distal parts of the biomechanical chain (Lees, 1996; Lees and Nolan, 1998). The foot speed in the instep kick is generated by the addition of the individual forces of the muscles acting around the lower back, pelvis, hip, knee and ankle joints (Young, Clothier, Otago, Bruce and Liddell, 2004).

The kicking action can be divided into six stages (Steyn, 2004), viz:

- The approach,
- Plant-foot forces,
- Swing-limb loading,
- Hip flexion and knee extension,
- Foot contact and
- Follow-through

Table 2.1 Muscular Action During Kicking Preparation (right-footed kick)

Body part	**Action**	**Muscles**
Trunk	Stabilisation of rotation to the right	Abdominals, psoas major, erector spinae and spinal postural muscles
Right hip	Extension	Gluteus maximus and hamstring muscle groups
Left hip	External rotation and eccentric extension	Gluteus medius, gluteus minimus, hamstring muscle group and adductor magnus
Right knee	Flexion	Hamstring muscle group and popliteus
Left knee	Eccentric extension	Quadriceps muscle group
Right ankle	Plantarflexion	Plantarflexors
Left ankle	Eccentric plantarflexion	Plantarflexors
Left shoulder	Abduction	Middle and anterior deltoid and supraspinatus

(http://www.sportsinjurybulletin.com/archive/biomechanics-soccer.htm, 2008)

According to Kellis and Katis (2007) the outcome of the kicking technique is highly dependent on the approach up to the ball. The resultant accuracy and ball speed of the kick is directly affected by the speed, distance and angle of the run-up. Greater kicking speeds have been noted to result from a 45º approach angle. During the approach/backswing phase the trunk rotates towards the kicking leg, the kicking leg extends and externally rotates slightly at the hip and is flexed and internally rotated at the knee. The kicking foot at this point is plantarflexed, abducted and pronated (non weight bearing). The approach phase ends as the non-kicking foot comes into contact with the floor (Kellis and Katis, 2007).

The positioning of the non-kicking foot is very important in the final outcome of the kicking technique (Ishmail, Mansor, Ali, Jaafar and Johar, 2010). In the case of the instep kick the non-kicking foot has to be in the right position in order to control the trajectory and the kicking foot position on impact so as to optimise foot speed and resultant ball speed following impact (Ishmail *et al.,* 2010). Estimation for the positioning of the foot on landing is seen in the literature as 5-10 cm behind and 5 – 28 cm next to the ball (Kellis and Katis, 2007).

At this point in the technique, with the non-kicking leg planted and slightly flexed at the knee, the hip of the kicking leg is still extending and the knee flexing. This functions to maximise the elastic energy stores in the muscles of the trunk and limb, and to allow for maximum torque around the joints on the downward phase of the kick. To complete the loading phase of the kicking process the hip is stopped at its maximum point of extension by the hip flexors and knee flexion is limited by the knee extensor muscles (Barfield, Kirkendall and Yu, 2002; Kellis and Katis, 2007).

The lower back and pelvis then initiate the forward motion of the kicking limb by rotating the trunk around and onto the supporting leg, which extends this limb. The hip flexors then maximally contract, throwing the leg forwards and downwards. The hip thus flexes and slightly adducts but it maintains its external rotation to allow for optimal foot positioning upon contact with the ball. The hip movement is shortly followed by forceful contraction of the knee extensors which propels and channels the forces down the leg towards the ball. The knee of the kicking leg then passes over the ball while still extending. At this point the foot is forcefully plantarflexed in preparation for contact (Barfield, Kirkendall and Yu, 2002; Kellis and Katis, 2007).

At the point of contact the kicking leg is moving forwards and upwards, the foot is in a fully plantarflexed position with the hip and knee both slightly flexed. A high foot velocity pre-contact will result in a shorter ball-foot contact time and therefore a greater resultant ball speed. During the contact phase the hip extensors and, more so, the knee flexors undergo forceful eccentric contraction to start slowing down and control the limb (Barfield, Kirkendall and Yu, 2002; Kellis and Katis, 2007; Ishmail *et al.,* 2010).

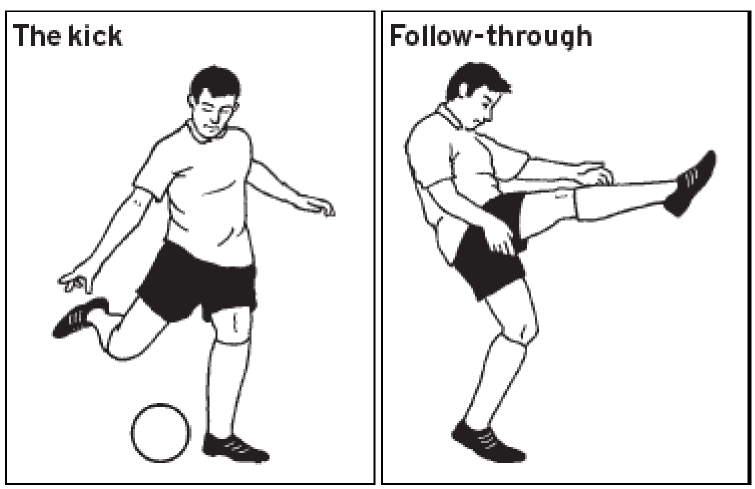


Figure 2.3 Illustration of the Body Position During the Kicking Action (www.sportsinjurybulletin.com/archive/biomechanics-soccer.htm , 2008)

The follow-through is very important in the kicking motion. A smooth follow-through will increase the force of the kick, as well as prevent any injury to the active eccentrically contracting muscles (Barfield *et al.*, 2002).

Table 2.2 Muscular Action During Follow-Through (right-footed kick)

Body Part	Action	Muscles
Right hip	Eccentric external rotation, eccentric extension and eccentric abduction	Hamstring group, posterior fibres of gluteus medius, quadratus femoris, piriformis and gluteus maximus
Right knee	Eccentric flexion	Hamstring group

(www.sportsinjurybulletin.com/archive/biomechanics-soccer.htm, 2008)

2.3.3 Kicking Speed

The velocity and accuracy of kicking can be vital in the outcome of the game (Sterzing and Henning, 2007). Kicking speed, while shooting at goal, is highly important in the shooting process as it gives the goalkeeper less time to react. Greater speeds in kicking will also result in the ability of passing the ball over greater distances (Dørge *et al.,* 2002). Kicking speeds vary according to the age, skill level, and run up distance of the players as depicted by **Table 2.3**

According to Kellis and Katis (2007) there are internal and external factors that affect the resultant speed of the ball following the kick: Internal factors such as individual strength, age, kicking technique, timing, foot used, and ROM of the full biomechanical chain and joints involved (ankle, knee, hip, sacroiliac, and lumbar joints) affect the resultant ball speed. Literature, supported by the results shown in **Table 2.3,** state that elite athletes exhibit a more refined and continuously reproducible kicking technique when compared to amateur players (Barfield, Kirkendall and Yu, 2002). External factors such as wind speed and direction, grass length, ball pressure and size also need to be taken into account (Kellis and Katis, 2007).

Table 2.3 Ball Speeds as Reported in the Literature (in m/s unless otherwise specified)

Research Study	*(n)*	Subject characteristics Age (Years)	Training status	Kick	Approach (steps – angle)	Ball speed (m/s)
Isokawa and Lees (1988)	6	20 – 26	Elite	Instep	1 step, 0° 1 step, 45° 1 step, 90°	18.73 (.95) 20.14 (1.58) 19.13 (1.64)
Poulmedis *et al.* (1988)	11	25.5 (3.0)	Elite	Instep	N/A	27.08 (1.32)
Dorge *et al.* (2002), 0°	7	26.4	Elite	Instep	3 m	24.7 (2.5)
Levanon & Dapena(1998)	6	Inter- collegiate	Elite	Instep	N/A	28.6 (2.2)
Barfield *et al.* (2002)	2	19-22	Elite	Instep	2 step, 45-60°	25.3 (1.51)
Barfield (1995)	18	20.7 (1.7)	Amateurs	Instep	2 step, 45-60°	26.4 (2.09)
Nunome *et al.* (2006b)	9	27.6 (5.6)	Elite	Instep	N/A	26.3 (3.4)
Apriantono *et al.* (2006)	7	20.0 (2.1)	Amateurs	Instep	N/A	28.4 (1.6)
Tol *et al.*, (2002)	15	27.4	Amateurs	Instep	N/A	18.9 – 29.8
Taina *et al.* (1993)	15	18.1 (.3)	Amateurs	Instep	N/A	96.02 (9.06) Km/h
Trolle *et al.* (1993)	24	N/A	Elite	Instep	N/A	99.3-103.6 Km/h
Manolopoulos *et al.* (2006)	10	19.9(.4)	Amateurs	Instep	2 step	27.9 (1.8)
Kellis *et al.* (2004)	10	21.3 (1.4)	Elite	Instep	1 step, 0° 1 step, 45° 1 step, 90°	19.79 (1.49) 20.41 (2.44) 18.51 (3.09)
Kellis *et al.* (2006)	10	22.6 (2.0)	Amateurs	Instep	2 step, pre-fatigue 2 step, post fatigue	24.69 (1.8) 21.78 (2.2)

Kicking speed and age data are means (±SD), (Kellis and Katis, 2007).

2.4 AN OVERVIEW OF THE BONY ANATOMY OF THE LUMBAR SPINE AND THE SACROILIAC JOINT AND THEIR ROM

2.4.1 Lumbar Spine

The lumbar spine typically consists of five consecutive vertebrae (L1-L5), and is located between the thoracic and sacral regions of the spine. The lumbar vertebrae are made up of the following structures, a spinous process, transverse processes, laminae, pedicles, superior and inferior articular processes, and a vertebral body (Moore and Dalley, 2005; Williams, Newell and Collins, 2005). The lumbar vertebrae differ from the thoracic vertebrae in the following ways (Moore and Dalley, 2005; Williams, Newell and Collins, 2005):

- No transverse foramina,
- No costal facets,
- Larger in size,
- Vertebral foramina are larger and more triangular in shape,
- Superior articular facets have mamillary processes,
- Vertebrae join to form a lordotic curve and
- Vertebral bodies are deeper and wider.

The lumbar vertebrae articulate together at the facet joints, also known as the zygapophyseal joints. The superior articular facets are vertical articular facets that are concave and posteromedially directed. The inferior articular facets are vertical articular facets that are convex and anterolaterally directed. The orientation of these facets allow for the following movements of the lumbar spine, flexion, extension, lateral flexion, with a small rotation motion. The spinous processes are short, thick, quadrangular and run horizontally. The long, laterally projecting transverse processes increase in length from the first to the third vertebrae and then shorten again towards the fifth (Moore and Dalley, 2005; Williams *et al.*, 2005).

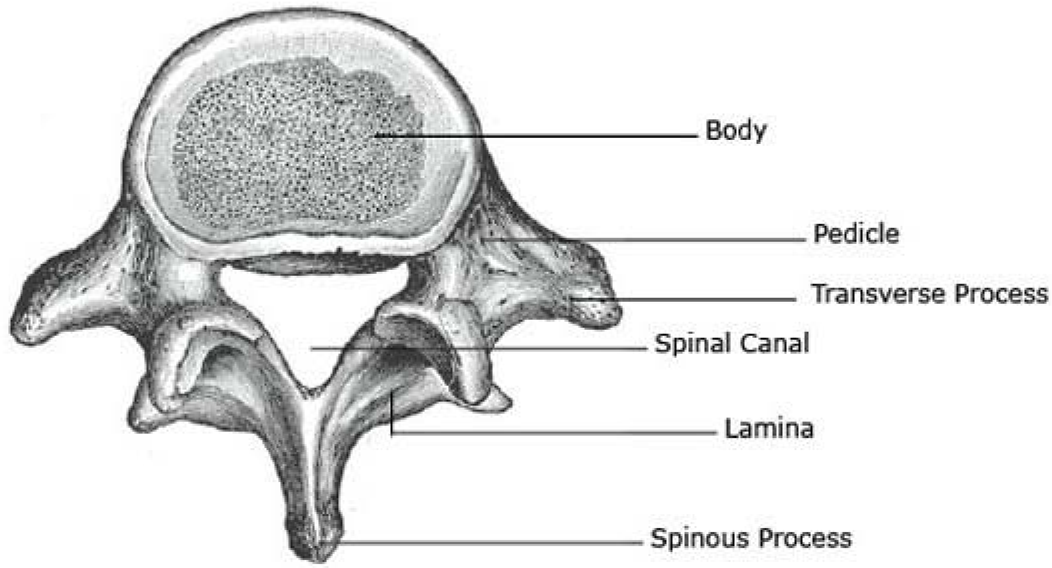


Figure 2.4 Labelled Diagram of a Lumbar Vertebra (http://healthpages.org/anatomy-function/lumbar-spine-lower-back-structure-function, 2010)

The major movements of the lumbar spine are flexion, followed by extension, lateral flexion and rotation. As per Saunders (1998), the normal ranges of motion values of these movements are:

- Flexion: ≥ 60º,
- Extension: ≥ 25º,
- Lateral flexion: 20º- 30º and
- Rotation: 5º-10º.

The lumbar facet joints receive sensory innervations from the medial branches of the posterior primary division of the nerves, at the level of the joint, as well as the level above and below the joint (Darby and Cramer, 1995).

2.4.2 Sacroiliac Joints

The sacroiliac joint (SI), the largest axial joint in the body, is formed by the articular surfaces of the ilium and the sacrum. The anterior third of the articular surfaces between the ilium and sacrum functions as a true synovial joint. This means there is no posterior capsule present in this joint. The void in function left by the absence of the posterior capsule is filled by an extensive ligamentous network connecting and aiding in stabilization of the sacroiliac joint. The SI joint is also supported structurally and functionally by muscles located in the gluteal region, namely, the gluteus maximus, piriformis, and biceps femoris which all attach to the SI ligaments (Cohan, 2005). Innervation of the SI joint is supplied by the anterior primary divisions of nerves L2-S2. These same nerves supply stimulation to both the femoral and tibial nerves (Cohan, 2005; Suter, McMorland, Herzog and Bray, 2000).

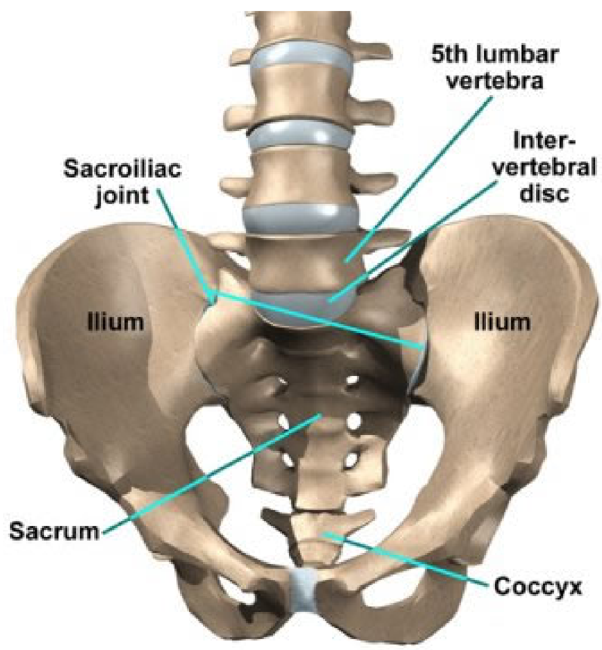


Figure 2.5 Diagram Illustrating the Sacroiliac Joint (Aldous, 2003) (www.vancouveryoga.com, 2003)

The SI joint is structurally designed to perform its main function, which is to increase pelvic stability, and to distribute truncal loads through the lower extremities (Cohan, 2005). As a result of this structural design, motion of the joint is compromised to increase function. However, with this said, the SI joint is still noted to move between 1.2º and 4º in all directions (Cohan, 2005).

2.5 THE ROLE OF THE LUMBAR SPINE AND THE SI JOINTS IN THE INSTEP KICKING TECHNIQUE

Gilchrist *et al*. (2003), explains that the joints of the lower limb function as a link system transmitting the forces generated during activities such as jumping, running and kicking, into the pelvis and spine as well as the pelvis and spine transmitting forces down the chain during these same actions.

The lumbar spine plays an axial role in the movement of the trunk and pelvis during the kicking technique. During the approach/backswing phase the lumbar spine rotates and extends allowing the trunk to rotate towards the kicking leg (Barfield, Kirkendall and Yu, 2002; Kellis and Katis, 2007; Ishmail *et al.,* 2010). At the end of the swing limb loading phase the lumbar spine is maximally rotated and extended. This allows for maximum distance and torque in the wind up. The swing phase is then initiated by the trunk, with the lumbar spine rotating towards the supporting leg to shift the weight onto the kicking foot and accelerate the kicking leg into flexion (Barfield, Kirkendall and Yu, 2002; Kellis and Katis, 2007; Ishmail *et al.,* 2010).

Throughout the kicking action, the lumbar spine, SI joints and the segmental muscles surrounding these joints closely control the compression forces being transferred towards the spine as well as stabilising and keeping the upper body balanced and upright (Gilchrist, Frey and Nadler, 2003).

Maximum motion of the SI joint noted in the comparison of literature performed by Cohan (2005) was no more than 4º in all directions. It is evident in the study done by Gilchrist *et al.*, (2003), that hip and sacroiliac musculature works together in the movement of the pelvis. Hence, during the kicking motion when the hip joint goes into full extension it causes the pelvis to tilt anteriorly and this puts the SI joint into an extended position. Similarly, it can be said that when the hip joint flexes, the pelvis tilts posteriorly and the SI joint assumes a flexed position (Kellis and Katis, 2007). During the foot planting phase, the SI joint is highly active absorbing and controlling the large amount of the force being transmitted through the body due to the impact of the supporting limb with the ground (Kellis and Katis, 2007).

Due to the open biomechanical nature of the kicking action (Dørge *et al*., 2002) the success and resultant speed of the kick is fully reliant on the body and limb momentum that can be created by muscular contractions and joint motions (Young *et al*., 2004). Therefore, maximum possible ROM of the joints involved is a necessity.

The body's functional ability is directly proportional to the balance between the bodily structures, bony structures and the joints. When this balance is lost, whether from trauma, over activity, or gradual compensatory shifting, stress accumulates and there is a decrease in function ability (Redwood, 2003).

Therefore, it is important to note that when considering joint dysfunction, that the spine and surrounding anatomy functions as a unit. "Dysfunction at one level can trigger compensatory changes at other spinal levels or in other areas (e.g., hip, knee, and ankle) of the musculoskeletal anatomy" (Redwood, 2003). Immobilization of a joint segment results in adverse changes in the surrounding ligaments, tendons, muscular tissue and vascular elements (Lederman, 2005). Functional implications of these changes are as follows: loss of tensile strength, adhesions, loss of flexibility and ROM, and muscle atrophy leading to a loss of functional ability (Lederman, 2005).

2.6 MOTION PALPATION, SPINAL MANIPULATION AND ROM

Motion palpation as indicated per Schafer and Faye (1990) and Bergmann, Peterson and Lawrence (1993) of the lumbar spine and sacroiliac joints is a technique utilased by practitioners to identify a fixated joint complex prior to manipulation. This is a manual procedure where the subject is seated with their back upright and arms folded across the chest. The practitioner uses the preferred surface of the hand to compare and feel for joint play (Schafer and Faye, 1990; Peterson and Lawrence, 1993)

A spinal manipulation is the use of a high velocity, short lever thrust of controlled amplitude on spinal articulations (Gatterman, 2003). This results in an increased joint mobility and an improved flexibility of the manipulated joint (Herzog, 2000; Gatterman, 2003), thus countering the effects of dysfunction and immobility. Along with the above mentioned effects, spinal manipulation is also thought to alter sensory and neurological signals from paraspinal tissues in a way that improves physiological function (Pickar, 2002). It is thought that spinal manipulation changes the neuromusculoskeletal system in that it impacts proprioceptive primary afferent neurons from paraspinal tissues and thus could affect the motor control system, increasing co-ordination and neurological firing (Pickar, 2002). This increased neurological input (Pickar, 2002) and the increased flexibility and mobility of the manipulated joints (Herzog, 2000; Gatterman, 2003) may result in increased speed of the biomechanical chain during the kicking motion (Suter *et al.,* 2000; Fox, 2006; Sood, 2008), as evidenced by findings in other sports related research; thus potentially increasing the resultant ball speed following impact.

Myburgh (1998) and Kruger (1999) on subjects symptomatic for lower back pain, reported statistically significant increases in lumbar ROM in all directions, post manipulative treatment over a two week period. The initial lumbar ROM measures in these studies were found to be below the normal measurements mentioned by Saunders (1998). These finding correspond with those of Kirkaldy-Willis and Bernard (1999), who stated that subjects with lumbar pain are likely to show decreased ROM measurements.

A study performed by Sood (2008), on asymptomatic subjects showed increased ROM findings immediately, within 10 minutes, post-manipulation on measurement with a digital inclinometer. Mayer, Kondraske, Beals and Gatchel (1997), found that there was minimal error when using an inclinometer, however where error might be seen is on the examiners ability to locate bony anatomical landmarks.

Bicalho, Setti, Macagnan, Cano and Manffra (2010), recently conducted a study which showed that a high velocity spinal manipulation had a positive effect on flexion and extension motions of the lumbar spine with a concurrent decrease in paraspinal muscle stiffness as result of the manipulation. Research by Suter *et al*., (2000) and Fox (2006) both showed that SI joint manipulation resulted in an increased knee extension capability, by increasing flexibility in the hamstrings as result of a decreased inhibition in the knee extensor muscles. The high involvement of knee flexion and extension in the kicking technique (Kellis and Katis, 2007), could render the findings of Fox, (2006) and Suter *et al*., (2000), valuable in increasing the kicking speed in soccer players.

2.7 THE HAWTHORNE AND PLACEBO EFFECTS

2.7.1 The Hawthorne Effect

Whenever subjective assessments are being utilized on subjects, the Hawthorne effect must be taken into consideration. The Hawthorne effect is an example of ‘the want to fit in’, as subjects make themselves appear well adjusted even though their answers may not be totally true (Mouton, 1996).

This phenomenon was first observed in the early 1920's when Hawthorne Works (electrical company) conducted an extensive research programme in methods to increase the productivity of employees (Roethlisberger and Dickson, 1939; Mayo, 1993). The results from the research showed increased productivity no matter what changes were made in the working environment. Later Franke and Kaul, (1978), defined this as "an increase in worker productivity produced by the psychological stimulus of being singled out and made to feel important". Subjects participating in clinical trials can also be included in this definition. The treatment response will be reviewed rather than the productivity (McCarney, Warner, Iliffe, Van Haselen, Griffin and Fisher, 2007). Due to the unique nature of the Hawthorne effect, special precautions need to be taken into consideration when performing a clinical trial, such as increased levels of clinical surveillance and extra attention by researchers (McCarney *et al.*, 2007). Hence, both the treatment and control groups must receive equal attention and thorough treatment interventions. However, most clinical trials are unable to properly quantify the magnitude of the Hawthorne effect (McCarney *et al.*, 2007).

2.7.2 The Placebo Effect

Wall and Wheeler (1996) believe 'placebo' to be derived from the term 'I shall please'. This form of interaction is usually used to compare against other treatment interventions, because placebo interventions only appeal to the psychological effect on subjects and not the physical interactions (McConnell and Philipchalk, 1992). The placebo effect is usually utilized as the control intervention by researchers because subjects are unaware if they are receiving the active treatment or not (Draper, 2002). This allows the researcher to ascertain the physical effects independently to the subjects' expectations. The placebo effect also occurs in subjects who receive spinal manipulation as a treatment intervention. Due to the fact that a mal-aligned vertebra is returning to its normal position, the audible cavitation, the manual contact involved in the procedure (Maigne and Vautravers, 2003) and a thorough explanation of a manipulation by the practitioner all contribute to this effect (Wilder, Pope and Frymoyer, 1988).

2.7.3 Similarities and Differences between the Hawthorne and Placebo Effects

These two phenomena purely affect subjects through psychological means, created by the subjects' perceptions. The Hawthorne effect brings out the subjects response due to their knowledge of being studied. However, the Placebo effect measures the efficiency of an inactive treatment intervention in order to have a control against which comparisons can be made. Placebo is derived purely from the subjects' false belief of the treatment intervention, whereas the subjects' response to being studied and receiving attention while participating is the main cause for the Hawthorne effect. In both cases the researcher manipulates and deceives the subjects with regards to the intervention they are receiving and this deception formulated by the researcher plays a very important role. However, the Placebo effect is crucial, in order for the intervention to be successfully measured (Draper, 2002).

2.8 CONCLUSION

With the instep kick being so effective and the outcome of a game of soccer being dependant on its execution, (Bir *et al*., 1995), it can be said that players should be performing this routine action at their maximum potential every time they kick a ball. Due to its open biomechanical nature, the kicking speed is a direct result of a summation of forces created by the muscles of the body as well as the momentum created by joint and limb movements (Lees, 1996; Lees and Nolan, 1998; Barfield *et al.,* 2002; Kellis and Katis, 2007). An increase in the distance over which the swinging leg can move, will increase the potential to achieve a higher foot speed at the point of impact (Young *et al.*, 2004).

The increased neurological input (Pickar, 2002), increased flexibility and mobility of joints and surrounding tissues resulting from manipulation (Herzog, 2000; Suter *et al.,* 2000; Gatterman, 2003; Bicalho *et al.*, 2010) may result in increased speed of the biomechanical chain during the kicking motion. This concurs with results found in other sports related research, which showed that increased movement through the biomechanical chain could potentially increase the resultant ball speed following foot-ball impact (Suter *et al.,* 2000; Fox, 2006; Sood, 2008).

Following the manipulative intervention, provided that external conditions were controlled (Kellis and Katis, 2007), the player could acquire the balance required between the bony structures and joints of the body (Redwood, 2003) and this could potentially result in an improved performance. However, there was limited published literature on the immediate post manipulation effect on the ROM of the lumbar and sacroiliac joints involved in the manipulation of asymptomatic subjects.

Therefore, the aim of this study was to determine whether manipulation of the lumbar spine and sacroiliac joints increases the ROM at the pelvis and trunk, resulting in a smoother, higher velocity kicking action and resultant ball speed.

CHAPTER THREE

METHODOLOGY

3.1 STUDY DESIGN

This was a quantitative, placebo-controlled, prospective trial.

3.2 ADVERTISING

Advertisements were placed on the action soccer notice boards as well as on the notice boards of the football clubs in the Durban area. Potential subjects were requested to contact the researcher telephonically for more information **(Appendix B)**.

3.3 SAMPLE SIZE AND SELECTION

A sample size of 40, asymptomatic subjects between the ages of 18 and 35 years were used in this study. Subjects were recruited through convenience sampling (Mouton, 1996) and divided into 4 groups of 10 according to their motion palpation findings.

3.4 THE CONSULTATION

Consultations were held in the Durban University of Technology Chiropractic Day Clinic and the Highway Action Arena in New Germany, where permission to use the premises was granted **(Appendix, J)**. For the consultations being held at the arena, the treatment area was curtained-off to provide the subjects with privacy. The entire research protocol or procedure was explained in detail by the researcher to every prospective subject. The subject then signed an informed consent form **(Appendix, A)** stating that they had been informed about the research topic and were willing to be a part of the research.

At the consultation each prospective subject underwent a medical case history, physical examination and a Lumbar spine and Pelvis orthopaedic examination **(Appendices C, D,** and **E** respectively).

3.4.1 Inclusion Criteria

1. Subjects had to be male.
2. Subjects had to be between the ages of 18 to 35 years.
3. The subjects had to have signed the Informed Consent Form **(Appendix, A)**.
4. The subjects had to be playing, in any position, for the regional premier soccer league, Castle league, Vodacom league, National first division or Premier league.
5. Subjects had to have clinical signs of a fixation (Lawrence, Bergmann and Peterson, 1993 and Gatterman, 2003) in either the lumbar spine or the sacroiliac joints or both.
6. Subjects had to be asymptomatic for clinical musculoskeletal symptoms.

3.4.2 Exclusion Criteria

1. Subjects who had contraindications to spinal manipulations, including but not limited to stress fractures, cauda equina syndrome, hyper mobility of vertebral segments, previous lower back surgery, tumours and bone infections (Bergmann, Peterson and Lawrence, 1993; Gatterman, 2003).
2. Subjects which after manipulation of the fixated joint did not have an increased ROM, on motion palpation, of that joint (Schafer and Faye, 1990; Bergmann, Peterson and Lawrence, 1993). In this study there were no subjects that did not increase in ROM, on motion palpation, post manipulation. However, in a clinical setting this may not be the case, so

therefore these results will only apply to subjects that increase ROM on motion palpation post manipulation.

3.4.3 Subject Informed Consent

If the subject agreed to take part in the study (after reading the subject information sheet, included in **Appendix A,** and verbal explanation of the study by the researcher), he was then given an Informed Consent Form **(Appendix, A)** to sign.

3.4.4 Group Allocation

Motion palpation as indicated per Schafer and Faye (1990) and Bergmann, Peterson and Lawrence (1993) of the lumbar spine and sacroiliac joints were performed, by both the researcher and the clinician, in order to determine the group allocation of the subject. If there was a disagreement between the clinician and the researcher then the findings of the clinician were taken as correct. Those subjects with no fixations in the palpated joints were placed into Group 4. The subjects with fixations were then placed into one of the three manipulative intervention groups by purposive allocation based on the area(s) in which the fixations are found. Those in Group 1 received lumbar manipulation, those in Group 2 received sacroiliac manipulation, those in Group 3 received both lumbar and sacroiliac manipulation and those in Group 4 received the sham laser technique.

3.4.5 Procedure

3.4.5.1 The Kick

Subjects were all instructed through a warm-up procedure prior to kicking to insure against any injuries. The warm-up was performed as per **Appendix, H**. The following instructions were given to each subject before kicking:

- Three instep kicks were to be performed at maximum power,
- The maximum run-up distance of 3 meters and,
- All three kicks were taken with the preferred foot only.

The angle of the run-up was not specified so as to not interrupt the subjects natural kicking technique (Dørge *et al.,* 2002).

3.4.5.2 The Manipulative Techniques

Kicking is accepted as a segmented motion pattern sequence which operates from the proximal-to-distal parts of an open biomechanical chain (Lees, 1996; Lees and Nolan, 1998; Dørge *et al.,* 2002). The lumbar spine and sacroiliac joint are both proximal parts of this lower biomechanical chain forming an axis for motion of the open chain movement, and initiating forward motion during kicking (Lees and Nolan, 1998; Kellis and Katis, 2007). For these reasons the manipulation of the lumbar spine and the SI joints were chosen for this study.

For lumbar manipulation, the lumbar roll technique was used as described by Szaraz (1990).

For the sacroiliac manipulation, a side lying technique was used with pisiform, posterior superior iliac spine contact as described by (Bergmann, Peterson, and Lawrence , 1993).

3.4.5.3 The Need for the Control Group (Group 4, Sham Laser Intervention)

As discussed in Section 2.7.1, the Hawthorne effect and Section 2.7.2, the Placebo effect are very commonly known to alter the results obtained in studies performed on subjects who are aware that their performance is being measured (McConnell and Philipchalk, 1992; McCarney *et al.,* 2007). In order to ascertain whether results in this study were not from the Placebo or Hawthorne effect but rather as a result of the intervention used, it was necessary to introduce a placebo/control group into the study.

The placebo (sham laser) intervention was performed as follows:
The subject was instructed to lie comfortably in a prone position on the treatment bed while the researcher plugged the laser unit into a power source. The laser unit was then switched on and the red colour created by the laser was demonstrated on the subjects hand (i.e. there was no change in the subjects sensation of temperature and touch by the laser). The subjects were instructed to keep their heads face-down into the bed as the light of the laser could be detrimental on ocular exposure. The researcher also wore protective goggles to authenticate the process. With the subjects lumbar spine exposed the laser unit was switched off and applied to the paraspinal muscles bilaterally for five minutes. The subjects ROM was then taken and the research process continued.

3.5 THE OUTCOME MEASURES

Outcome measures for this research included the following:

- ROM of the lumbar spine in flexion, extension, lateral flexion and rotation movements, measured pre and post warm-up routine and post intervention with the digital inclinometer.
- Flexion ROM of the SI joints, measured pre and post warm-up routine and post intervention with the digital inclinometer.
- Kicking speed measured with the Speed Trac™ Speed Sport Radar. (km/h).
- Subjects perception of the kicking speed post intervention. Recorded in **Appendix G**.

3.6 MEASUREMENT TOOLS

3.6.1 Saunders Digital Inclinometer

The Saunders digital inclinometer (The Saunders Group, Chaska, MN) consists of a sensor with a digital display, an alternate zero button (to 'zero' the unit), a hold button, an on/off button and two Velcro straps. If the sensor is tilted e.g. 15º in any direction, then it will read 15º. If it is zeroed at 15º and then moves e.g. to 30º in any direction, then it will read 30º. Mayer, Kondraske, Beals and Gatchel, (1997), found that there was minimal error when using an inclinometer, however where error might be seen is on the examiners ability to locate bony anatomical landmarks.

ROM of the lumbar spine and sacroiliac joints was performed pre and post warm up routine and post intervention, measured with the digital inclinometer.

Lumbar range of motion: flexion, extension, lateral flexion and rotation motion was assessed.

- Flexion: The Saunders digital inclinometer was placed at the level of the sacral midpoint, with the subject fully flexed, the inclinometer is then zeroed. The inclinometer was then placed at the T12-L1 interspace, and the reading recorded (Saunders, 1998).
- Extension: The same steps as per the flexion measurements were followed except the subject was fully extended (Saunders, 1998).
- Lateral flexion: With the ruler attachment added, the inclinometer was placed across the inferior aspect of the left and right posterior superior iliac spine (PSIS) and zeroed. The subject then maximally flexed laterally without movement of the pelvis, and weight bearing remaining equal on each foot. In the laterally flexed position readings were taken with the inclinometer perpendicular to the spine at the level of the inferior aspect of the PSIS (1) and at the T12-L1 interspace (2). Reading 1 subtracted from reading 2 left the resultant lateral flexion ROM in the lumbar spine itself.

Readings were taken with the subjects laterally flexed to both the left and right (Saunders, 1998).

- Rotation: With the ruler attachment added, the inclinometer was placed across the inferior aspect of the left and right posterior superior iliac spines (PSIS) and zeroed. The subject then forwardly flexes and then rotated to either side. In the flexed and rotated position readings were taken with the inclinometer placed perpendicular to the spine at the level of the inferior aspect of the PSIS's (1) and at the T12-L1 interspace (2). Reading 1 was subtracted from reading 2 and left the resultant rotation ROM in the lumbar spine. Readings were taken with the subjects laterally flexed to both the left and right (Saunders, 1998).

Sacroiliac Range of Motion (Flexion motion was assessed)

The Saunders digital inclinometer was placed at the level of the sacral midpoint with the subject standing upright. The subject was then asked to perform forward flexion of the trunk. The examiner then palpated the subjects greater trochanter and at the point where this movement was initiated, the reading was taken. This isolated the movement to the SI joints (Saunders, 1998). The subject was then asked to stand upright leaning against the wall, as per Gillets test (Schafer and Faye, 1990; Bergmann, Peterson and Lawrence, 1993). The inclinometer was placed down the centre of the lateral aspect of the thigh and zeroed. The subject then maximally flexed the leg towards the chest and at maximal motion a reading was taken. The PSIS on the side of the active limb was then palpated and the subject asked to then perform the same motion. At the point where the PSIS engaged in motion, the subject was asked to hold the limb there and another reading was taken. The second reading was subtracted from the first reading to leave only the sacroiliac joint motion (Arab *et al.*, 2009).

3.6.2 SpeedTrac™ Speed Sport Radar

This device (EMG Companies, Wisconsin, USA) utilized Doppler signal processing to measure speeds of small projectiles. An internal antenna sends out radio waves at a specific frequency, so when a moving object, such as a kicked ball, enters the range of this signal it alters the frequency. The frequency of the reflected signal off the ball changes the frequency in proportion to the ball's speed. The radar then displays the speed in the units of choice, in this case km/h. The signal transmitted is able to pass through materials such as plexiglas, netting, white mesh fencing, backdrops, or tarpaulins without being affected. Therefore, a protective barrier can be placed between the moving object and the radar without affecting the accuracy of the measurements in any way. The speed range of the radar is 10-199 km/h, and the distance range is approximately nine meters. The accuracy of the radar is within 2-3 km/h (Sood, 2008). In research conducted by both Sood, (2008) and Hilligan, (2008) this particular radar gun demonstrated accuracy and reliability.

The SpeedTrac™ Speed Sport Radar was set up, in the indoor arena behind the netting of the goal, so as to:

- Protect the unit;
- Give the most accurate readings (7.5 meters away from the kicking point) and
- To give the subjects a target to aim for.

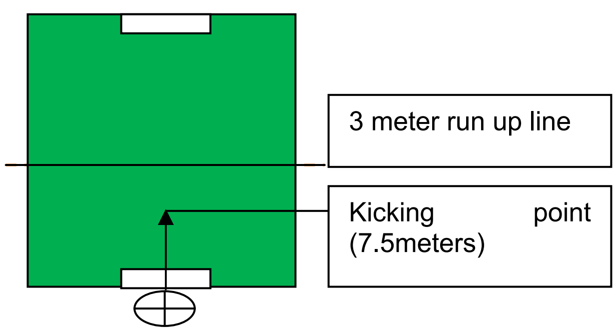


Figure 3.1 Set-up of the SpeedTracTM Speed Sport Radar at the Action Arena

3.6.3 Subjects' Perception of Kicking Speed

Subjects were all required to answer the following question post intervention, "Did you feel that your kicking speed increased or decreased or remained the same following the treatment?" **(Appendix, G)**

3.7 ETHICAL CONSIDERATIONS IN THIS STUDY

Attached, is an Informed Consent Form and letter of information, which was signed by all subjects in this study **(Appendix, A)**. The subjects were also given a verbal description of the research by the researcher prior to taking part in the study.

All subjects involved in this study were asymptomatic for clinical musculoskeletal symptoms. Subjects were thoroughly examined, by means of a full medical history, physical examination and lumbar regional examination for contraindications to spinal manipulation before inclusion in this study.

Some degree of deception was required in this study in that the subjects in Group 4 were told that they were receiving a genuine therapeutic laser intervention. Since all subjects were healthy and asymptomatic, it was anticipated that there would be no adverse consequences for the subjects in the sham laser intervention group. Following the recording of the post intervention data readings, the subjects were informed that the laser unit was not switched on and that there was no actual laser intervention. The subjects were then asked if they would allow the researcher to include their data gathered for analysis. If the subject did not allow the researcher to use the data then the data was suitably discarded at the Action arena.

A qualified chiropractor was present on-site to supervise the entire procedure for all consultations.

3.8 STATISTICAL ANALYSIS

SPSS version 15.0 was used to analyse the data. A p value ≤ 0.05 indicated statistical significance. Demographic characteristics were compared between the groups using ANOVA tests. Intra-group comparisons of outcomes over time were achieved using within-subjects repeated measures ANOVA. A significant time effect indicated a significant effect of the intervention where each subject was used as their own control. Intra-group comparison of interventions was achieved using between and within groups repeated measures ANOVA. A significant time verses group effect indicated that the interventions produced different results over time. Comparison of subjective and objective change in kicking speed was assessed using cross tabulations and Pearson's chi square tests (Esterhuizen, 2010). **(Appendix, I)**

CHAPTER FOUR

RESULTS

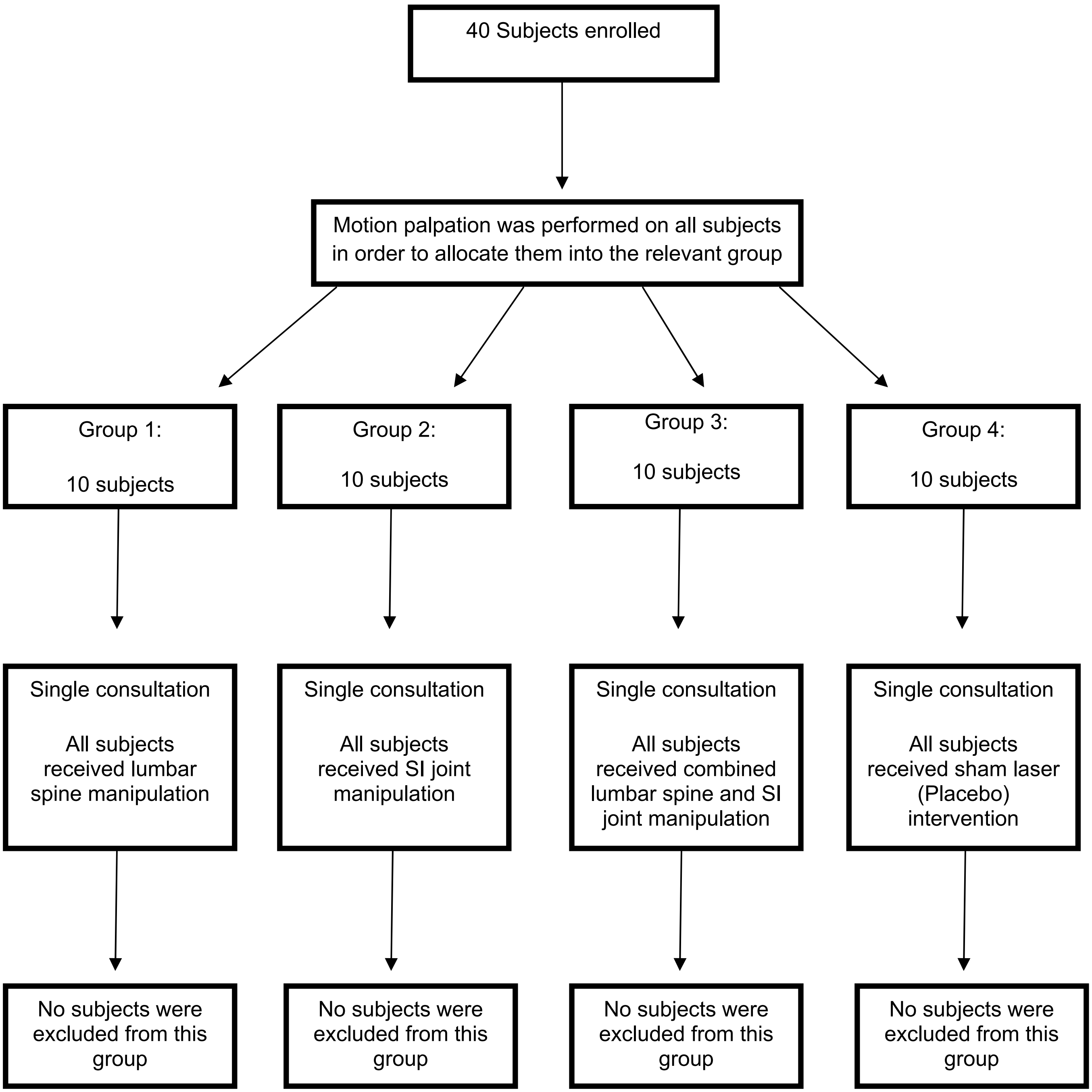
4.1 INTRODUCTION

Included in this chapter are the results of the study performed as per the methodology. The raw data captured to produce the results seen in this chapter can be viewed in **Appendix O**. The discussion of these results will follow in Chapter Five.

4.2 TOOLS USED IN OBTAINING DATA

The objective tools used were: The Speed Trac™ Speed Sport Radar, which measured kicking speed in kilometres per hour (km/h), and the Saunders digital inclinometer. The subjective tool used was a question based on the subjects' perception of the kicking post intervention.

Figure 4.1 Flow Diagram Showing Subject Intake and Group Allocation



4.3 PHYSICAL CHARACTERISTICS AND DEMOGRAPHIC DATA

Table 4.1: Comparison of Demographics by Group

There were no significant differences between the four groups with regards to age, height or weight.

	Group								*p value*
	Lumbar spine manipulation		SI joint manipulation		Combined		Sham		
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	
Height(cm)	175.3	4.3	175.6	6.6	180.6	8.5	177.3	3.9	0.209
Weight(kg)	75.6	5.6	75.8	11.1	81.9	8.0	75.3	7.1	0.234
Age(years)	23.5	3.4	24.1	4.0	23.1	3.4	23.0	2.9	0.890

4.4 REVIEW OF OBJECTIVES

4.4.1 Objective One

To determine the immediate effect (pre and post intervention) of lumbar spine manipulation on the lumbar ROM and the kicking speed in soccer players, in terms of the subjective and objective measurements.

4.4.1.1 Range of Motion Findings for Group 1

Table 4.2 Range of Motion

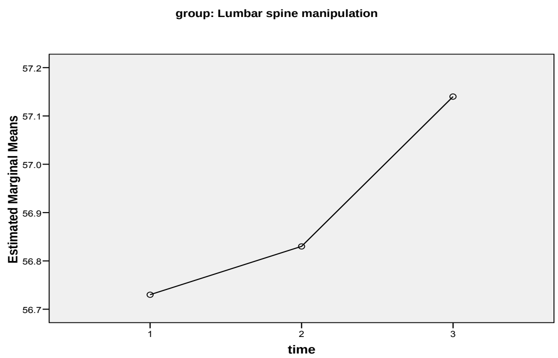
Movement	Effect	Statistic	*p value*
Flexion	Time	Wilk’s lambda = 0.645	0.173
Extension	Time	Wilk’s lambda = 0.590	0.121
Left Lat. Flex.	Time	Wilk’s lambda = 0.600	0.130
Right Lat Flex	Time	Wilk’s lambda = 0.573	0.107

Left Rotation	Time	Wilk’s lambda = 0.403	0.026
Right Rotation	Time	Wilk’s lambda = 0.265	0.005

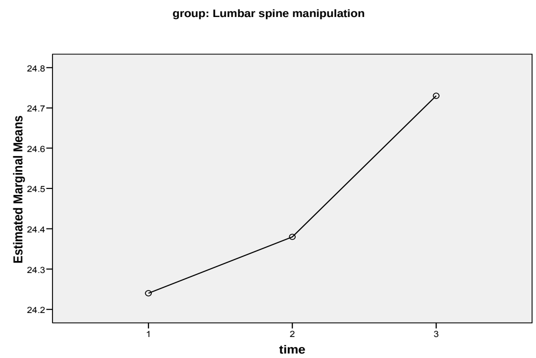
Statistically significant results were noted in the post intervention measurements of both left ($p = 0.026$) and right rotation ($p = 0.005$) of the lumbar spine. There were no statistically significant increases in ROM post warm-up.

The results for sacroiliac ROM changes were statistically insignificant ($p > 0.05$). See **Appendix L** for the results.

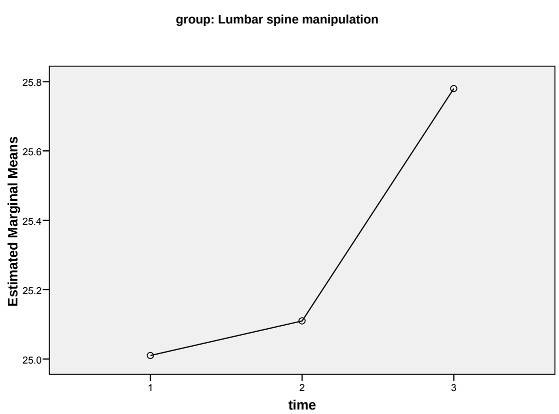
Flexion



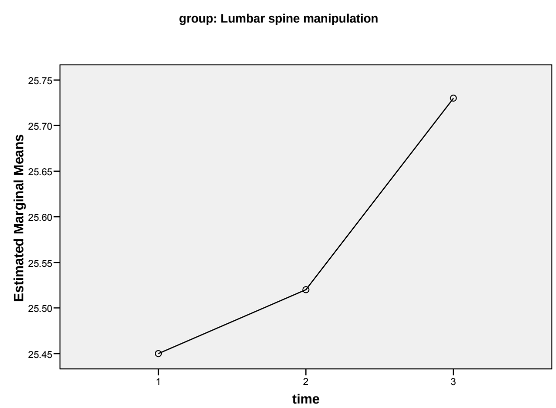
Extension



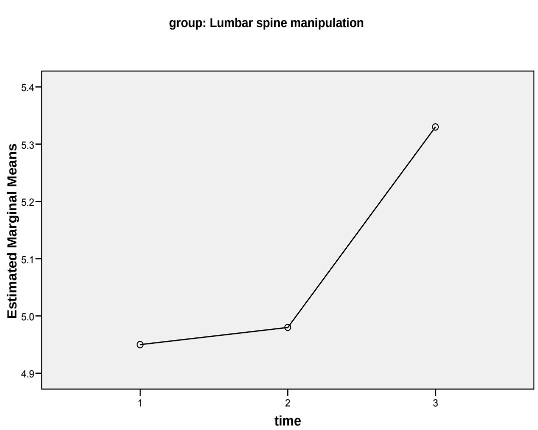
Left Lateral Flexion



Right Lateral Flexion



Left Rotation



Right Rotation

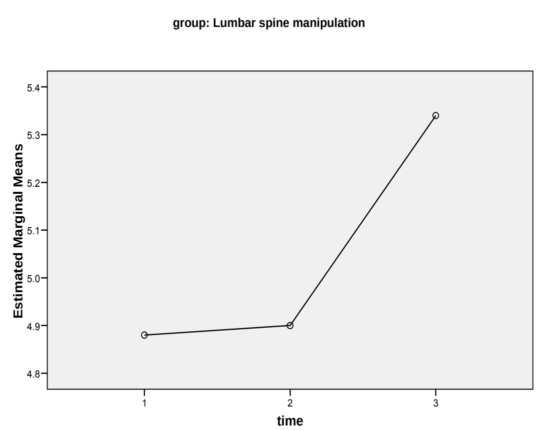


Figure 4.1 Results of ROM Changes in Group 1

4.4.1.2 Kicking Speed Findings for Group 1

Table 4.3 Kicking Speed

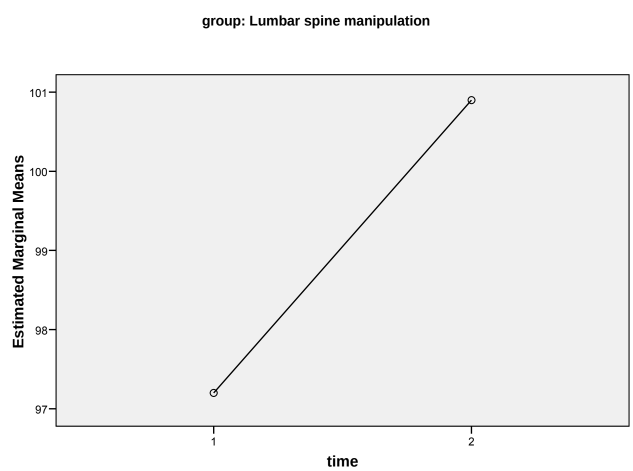
Kicking Speed	Effect	Statistic	*p value*
Avg. Kicking Speed	Time	Wilk's lambda = 0.454	0.009
Max. Kicking Speed	Time	Wilk's lambda = 0.574	0.029

There was a significant effect of this intervention on both the average kicking speed (p = 0.009) and the maximum kicking speed (p = 0.029).

Figure 4.3 Graphs Showing the Kicking Speeds of Subjects in Group1 Pre and Post Intervention (km/h)

Average Kicking Speed

Maximum Kicking Speed



4.4.2 Objective Two

To determine the immediate effect (pre and post intervention) of sacroiliac joint manipulation on the sacroiliac ROM and the kicking speed in soccer players, in terms of the subjective and objective measurements.

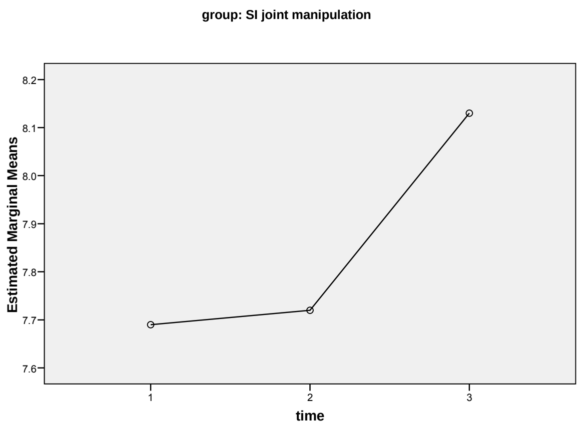
4.4.2.1 Range of Motion Findings for Group 2

Table 4.4 Range of Motion

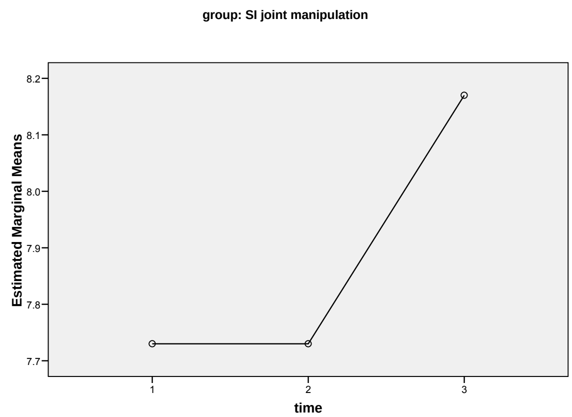
Movement	Effect	Statistic	*p value*
Left SI Flexion 1	Time	Wilk's lambda = 0.671	0.202
Left SI Flexion 2	Time	Wilk's lambda = 0.721	0.095
Right SI Flexion 1	Time	Wilk's lambda = 0.691	0.229
Right SI Flexion 2	Time	Wilk's lambda = 0.632	0.159

There was no statistically significant effect of this intervention noted on both SI ROM tests both post warm-up and post intervention ($p > 0.05$).

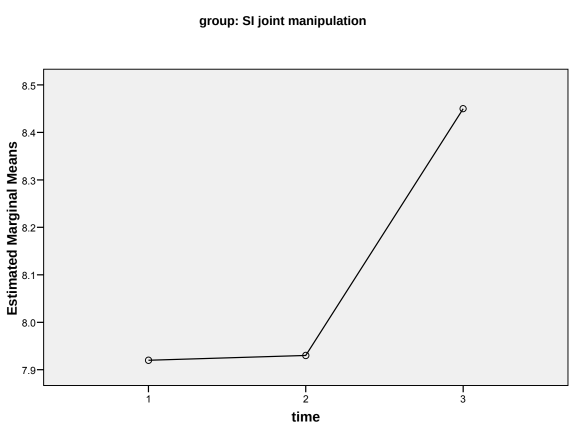
Left Sacroiliac 1



Left Sacroiliac 2



Right Sacroiliac 1



Right Sacroiliac 2

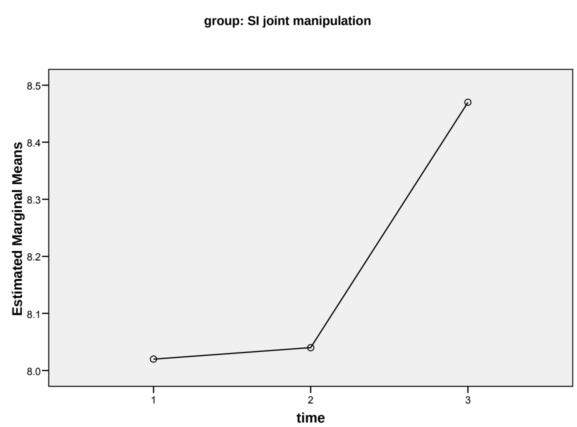


Figure 4.4 Results of ROM Changes in Group2

Lumbar ROM changes for Group 2 were statistically insignificant but there was a slight increase in the extension and rotation motions. No changes were noted in flexion and lateral flexion motions. These results can be seen in **Appendix L.**

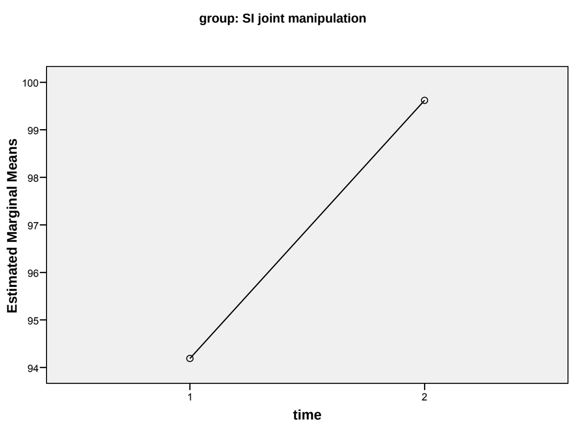
4.4.2.2 Kicking Speed Findings for Group 2

Table 4.5 Kicking Speed

Kicking Speed	Effect	Statistic	*p value*
Avg. Kicking Speed	Time	Wilk's lambda = 0.279	0.001
Max. Kicking Speed	Time	Wilk's lambda = 0.292	0.001

There was a significant effect of this intervention on both the average kicking speed (p = 0.001) and the maximum kicking speed (p =0.001).

Average Kicking Speed



Maximum Kicking Speed

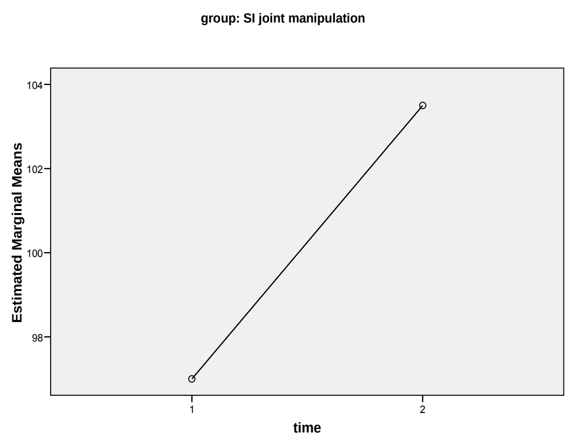


Figure 4.5 Graphs Showing the Kicking Speeds of Subjects in Group 2 Pre and Post Intervention (km/h)

4.4.3 Objective Three

To determine the immediate effect (pre and post intervention) of a combination of lumbar spine and sacroiliac joint manipulation on the lumbar and sacroiliac ROM and the kicking speed in soccer players, in terms of the subjective and objective measurements.

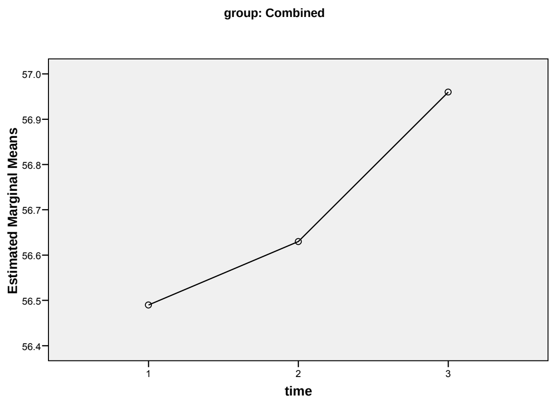
4.4.3.1 Range of Motion Findings for Group 3

Table 4.6 Range of Motion

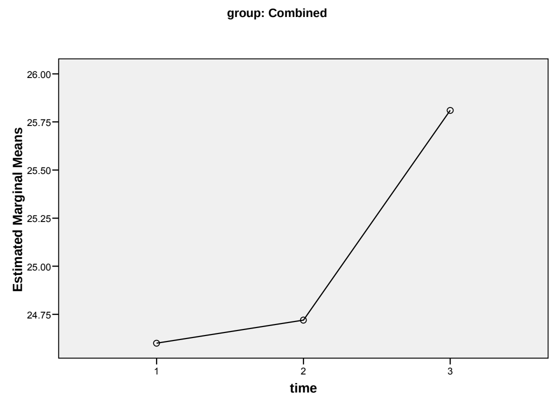
Movement	Effect	Statistic	*p value*
Flexion	Time	Wilk's lambda = 0.643	0.162
Extension	Time	Wilk's lambda = 0.346	0.014
Left Lat. Flex.	Time	Wilk's lambda = 0.759	0.125
Right Lat Flex	Time	Wilk's lambda = 0.553	0.094
Left Rotation	Time	Wilk's lambda = 0.167	0.001
Right Rotation	Time	Wilk's lambda = 0.272	0.005
Left SI Flexion 1	Time	Wilk's lambda = 0.616	0.144
Left SI Flexion 2	Time	Wilk's lambda = 0.643	0.052
Right SI Flexion 1	Time	Wilk's lambda = 0.495	0.060
Right SI Flexion 2	Time	Wilk's lambda = 0.549	0.024

There was no statistically significant change in ROM post warm-up. There was a significant effect of this intervention on extension ($p = 0.014$), left ($p = 0.001$) and right rotation ($p = 0.005$) and right SI flexion 2 ($p = 0.024$).

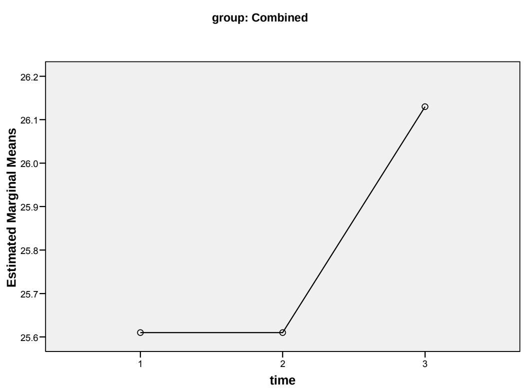
Flexion



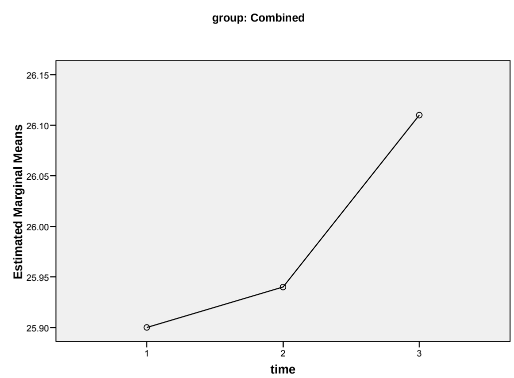
Extension



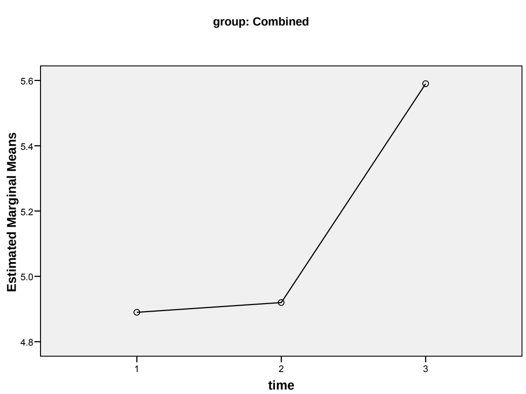
Left Lateral Flexion



Right Lateral Flexion



Left Rotation



Right Rotation

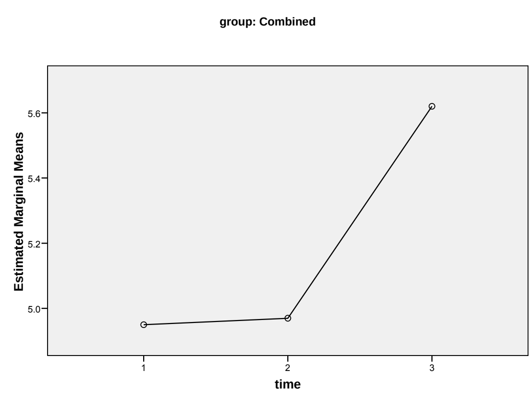
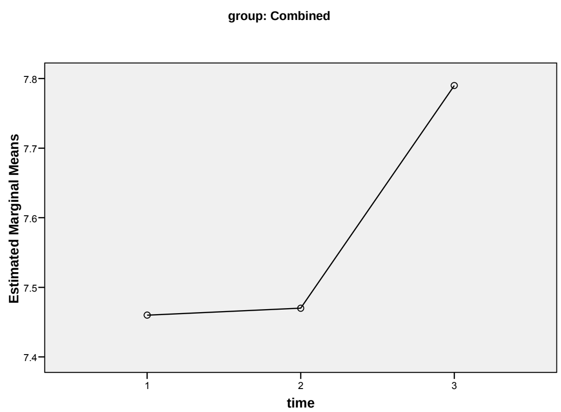
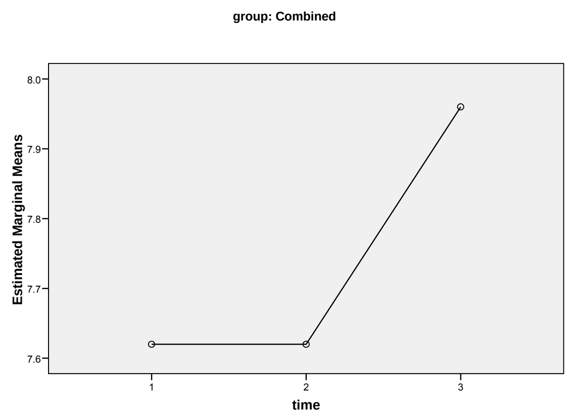


Figure 4.6 Results of ROM Changes in Group 3

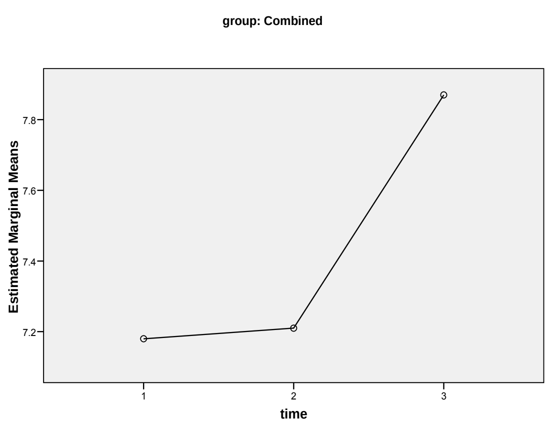
Left Sacroiliac 1



Left Sacroiliac 2



Right Sacroiliac 1



Right Sacroiliac 2

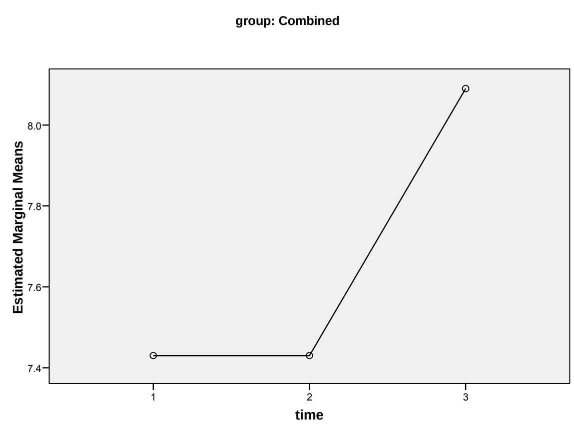


Figure 4.6 CONTD.

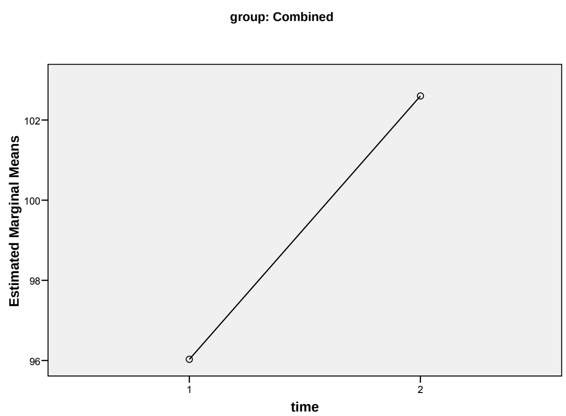
4.4.3.2 Kicking Speed Findings for Group 3

Table 4.7 Kicking Speed

Kicking Speed	Effect	Statistic	*p value*
Avg. Kicking Speed	Time	Wilk's lambda = 0.177	< 0.001
Max. Kicking Speed	Time	Wilk's lambda = 0.343	0.002

There was a highly significant effect of this intervention on the average kicking speed ($p < 0.001$), as well as the maximum kicking speed ($p = 0.002$).

Average



Maximum

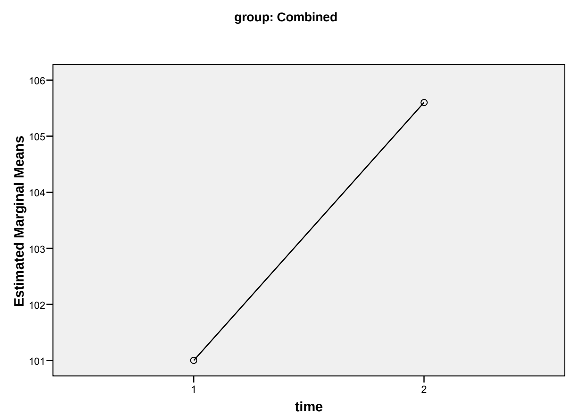


Figure 4.7 Graphs Showing the Kicking Speeds of Subjects in Group 3 Pre and Post Intervention (km/h)

4.4.4 Objective Four

To determine the immediate effect (pre and post intervention) of sham laser technique on the lumbar spine and sacroiliac joint ROM and the kicking speed in soccer players, in terms of the subjective and objective measurements.

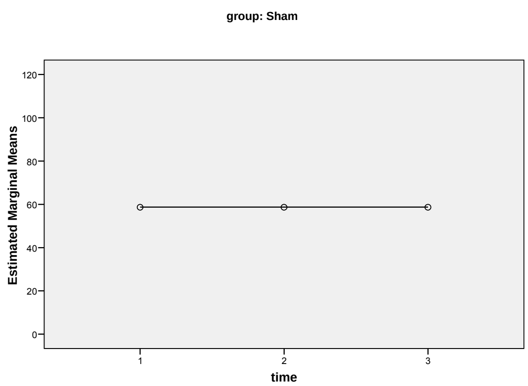
4.4.4.1 Range of Motion Findings for Group 4

Table 4.8 Range of Motion

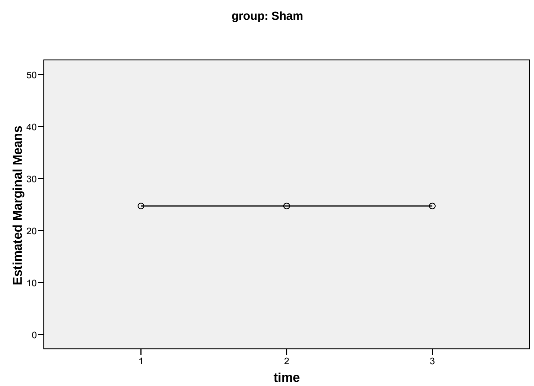
Movement	Effect	Statistic	*p value*
Flexion	Time	Wilk’s lambda =.	0
Extension	Time	Wilk’s lambda =.	0
Left Lat. Flex.	Time	Wilk’s lambda =.	0
Right Lat Flex	Time	Wilk’s lambda =.	0
Left Rotation	Time	Wilk’s lambda = 0.720	0.269
Right Rotation	Time	Wilk’s lambda = 0.622	0.150
Left SI Flexion 1	Time	Wilk’s lambda = 0.900	0.343
Left SI Flexion 2	Time	Wilk’s lambda = 0.900	0.343
Right SI Flexion 1	Time	Wilk’s lambda = 0.900	0.343
Right SI Flexion 2	Time	Wilk’s lambda = 0.900	0.343

There was no statistically significant effect of the warm-up or the Sham laser intervention on any of the ROM measurements in the lumbar spine or SI joint ($p > 0.05$).

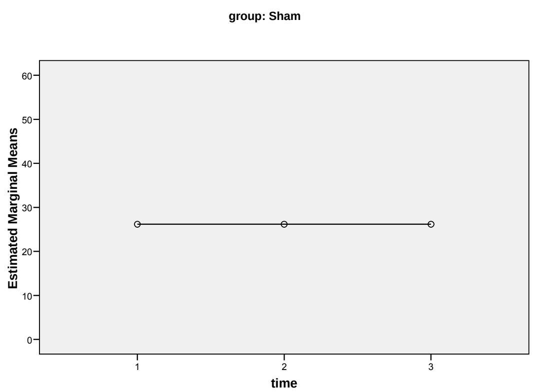
Flexion



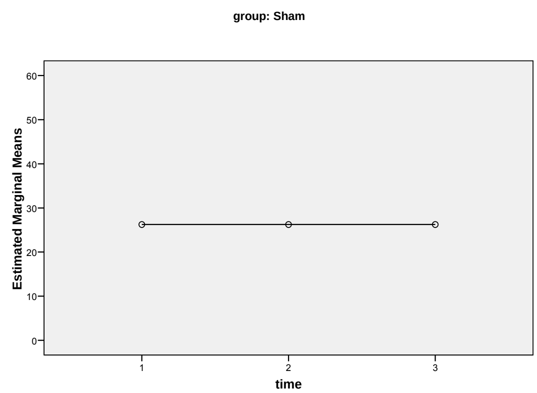
Extension



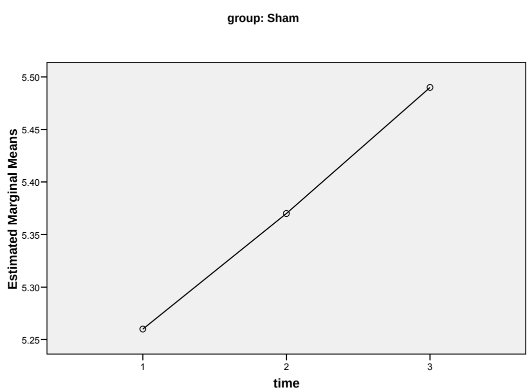
Left Lateral Flexion



Right Lateral Flexion



Left Rotation



Right Rotation

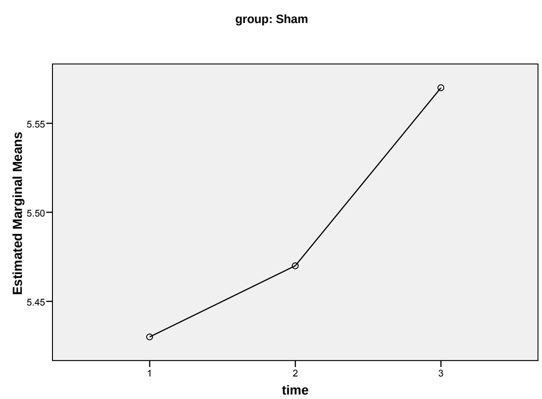
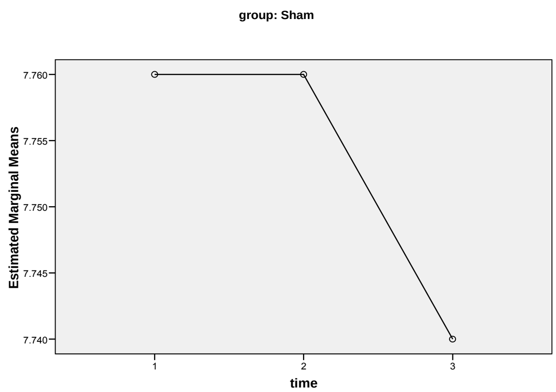
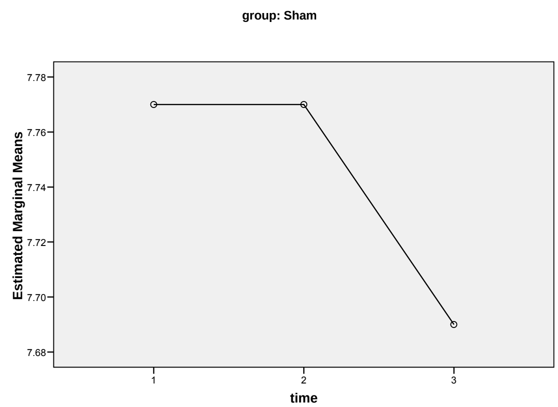


Figure 4.8 Results of ROM Changes in Group 4

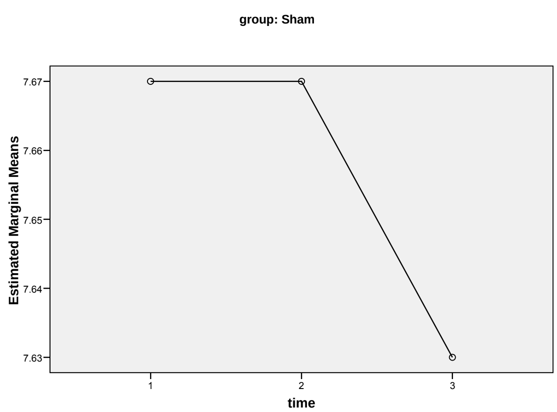
Left Sacroiliac 1



Left Sacroiliac 2



Right Sacroiliac 1



Right Sacroiliac 2

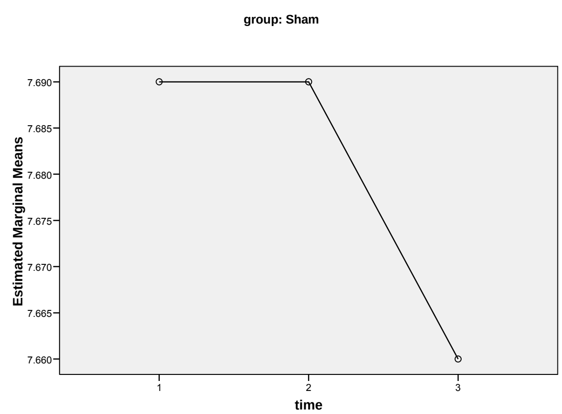


Table 4.7 Contd.

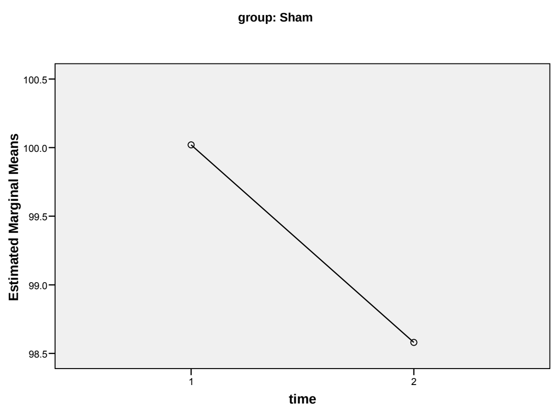
4.4.4.2 Kicking Speed Findings for Group 4

Table 4.9 Kicking Speed

Kicking Speed	Effect	Statistic	*p value*
Avg. Kicking Speed	Time	Wilk's lambda = 0.680	0.070
Max. Kicking Speed	Time	Wilk's lambda = 0.723	0.096

There was no statistically significant effect of the control on either the average (*p* = 0.07) or the maximum kicking speeds (*p* = 0.096). If any, there was a slight decrease in the speeds post intervention.

Average Maximum



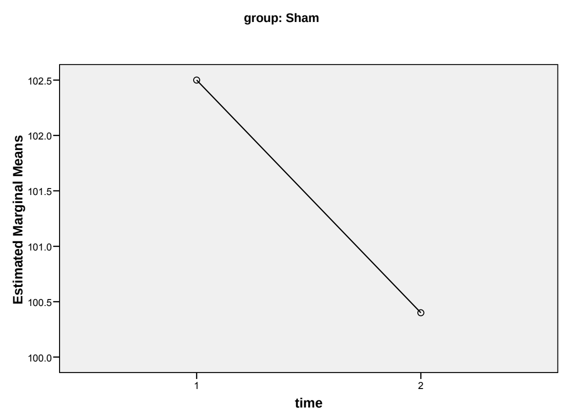


Figure 4.9 Graphs Showing the Kicking Speeds of Subjects in Group4 Pre and Post Intervention (km/h)

4.4.5 Objective Five

To compare the subjective and objective measures for all groups.

4.4.5.1 Lumbar Flexion

There was no difference between the four treatments in lumbar flexion over time (*p*=0.183). The figure shows that while there was some improvement in the combined and lumbar manipulation group, the effect was small and not different to the group which showed no change over time.

Table 4.10 Inter-group Lumbar Flexion Comparison

Effect	Statistic	*p value*
Time	0.785	0.015
Time*Group	0.782	0.183
Group	0.515	0.675

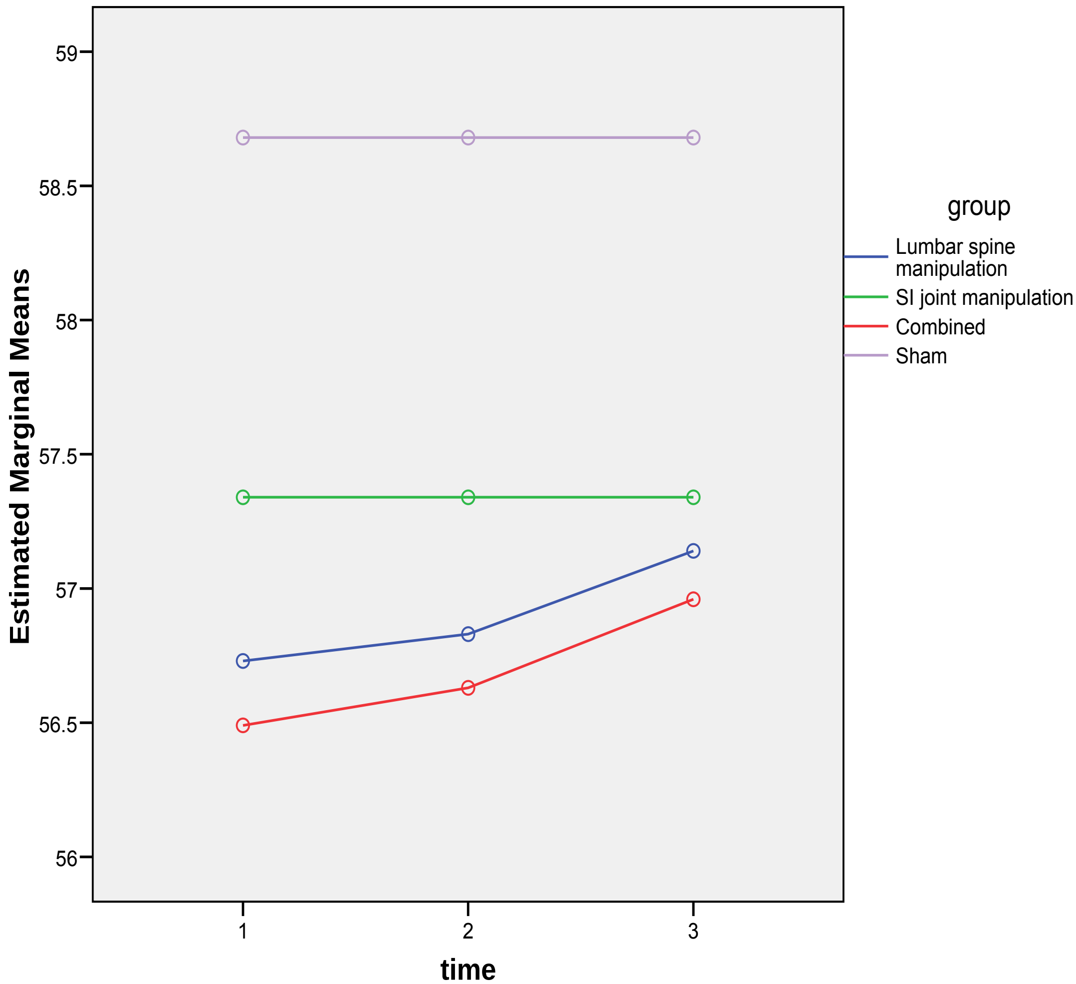


Figure 4.10 Graph Showing Inter-Group Lumbar Flexion Comparison

4.4.5.2 Lumbar Extension

There was a differential treatment effect in the four groups (*p* = 0.003). The figure shows that it was the combined group which showed the greatest effect for extension.

Table 4.11 Inter-group Lumbar Extension Comparison

Effect	Statistic	*p value*
Time	0.603	< 0.001
Time*Group	0.571	0.003
Group	0.291	0.832

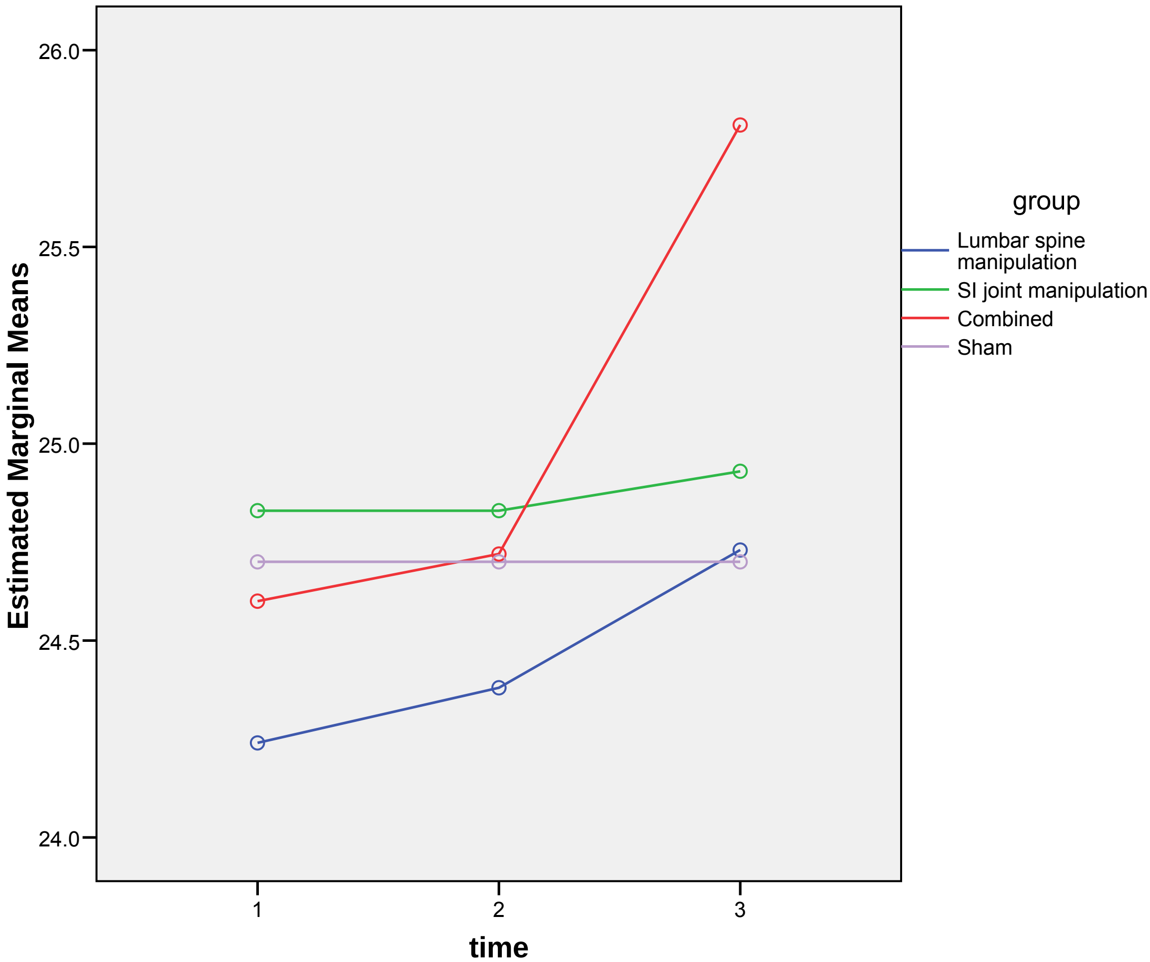


Figure 4.11 Graph Showing Inter-Group Lumbar Extension Comparison

4.4.5.3 Lumbar Left Lateral Flexion

While the figure shows a trend towards a higher rate of improvement in the combined and lumbar manipulation groups, the difference was not statistically significant.

Table 4.12 Inter-group Lumbar Left Lateral Flexion Comparison

Effect	Statistic	*p value*
Time	0.804	0.022
Time*Group	0.757	0.124
Group	0.588	0.627

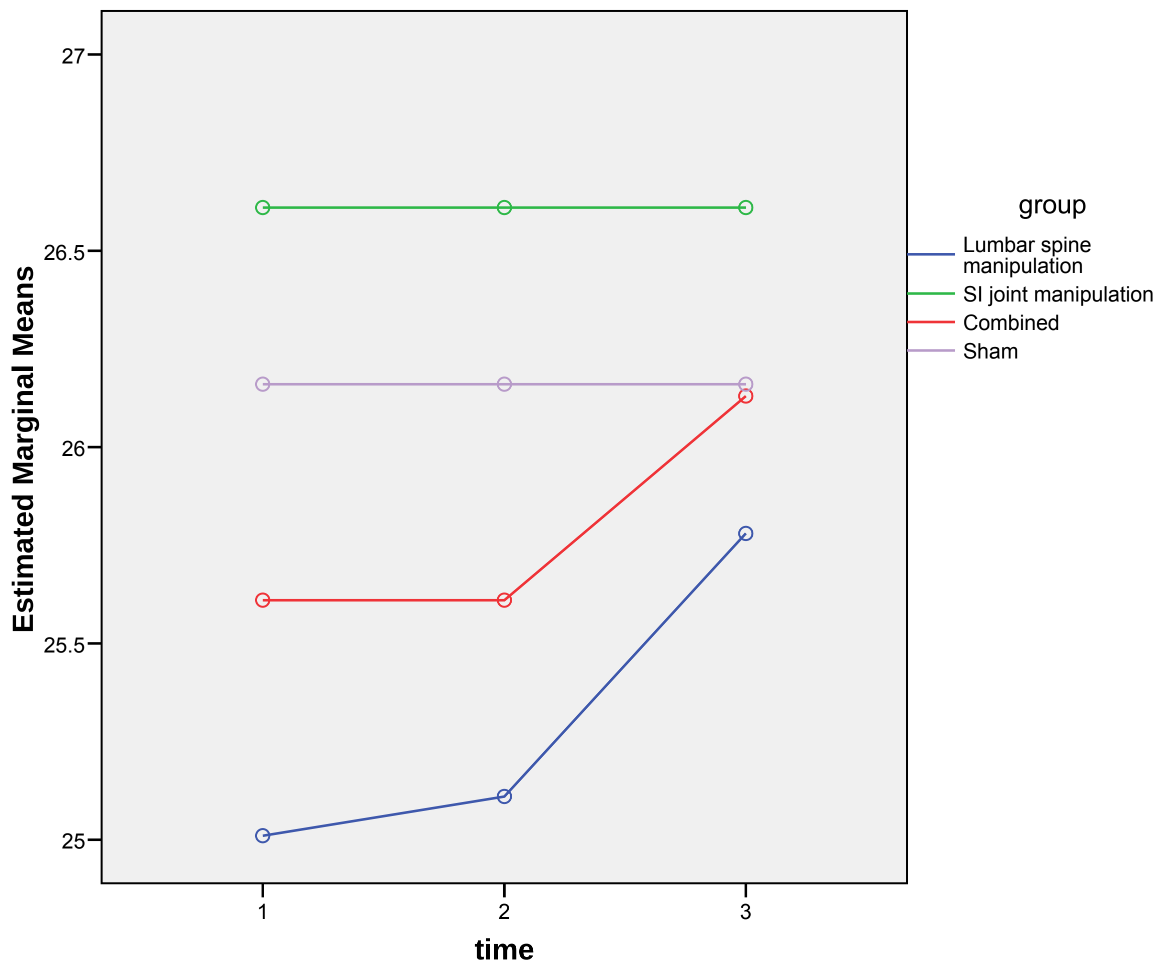


Figure 4.12 Graph Showing Inter-Group Lumbar Left Lateral Flexion Comparison

4.4.5.4 Lumbar Right Lateral Flexion

While the figure shows a trend towards a higher rate of improvement in the combined and lumbar manipulation groups, the difference was not statistically significant.

Table 4.13 Inter-group Lumbar Right Lateral Flexion Comparison

Effect	Statistic	*p value*
Time	0.733	0.004
Time*Group	0.714	0.059
Group	0.453	0.717

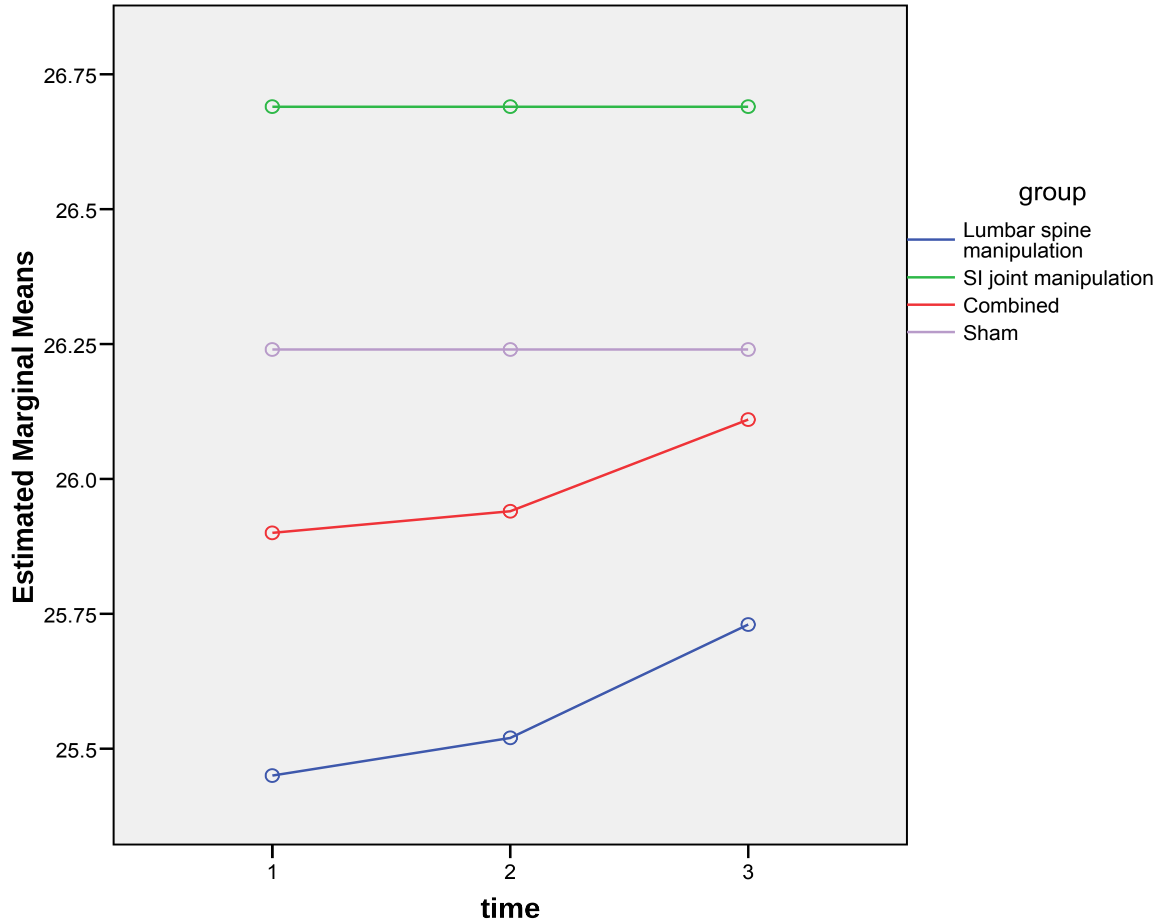


Figure 4.13 Graph Showing Inter-Group Lumbar Right Lateral Flexion Comparison

4.4.5.5 Lumbar Left Rotation

There was a statistically significant difference in the treatment groups effects over time (*p* = 0.001). The figure shows that the combined Sacroiliac and lumbar manipulation groups fared better than the other groups.

Table 4.14 Inter-group Lumbar Left Rotation Comparison

Effect	Statistic	*p value*
Time	0.421	< 0.001
Time*Group	0.518	0.001
Group	1.918	0.144

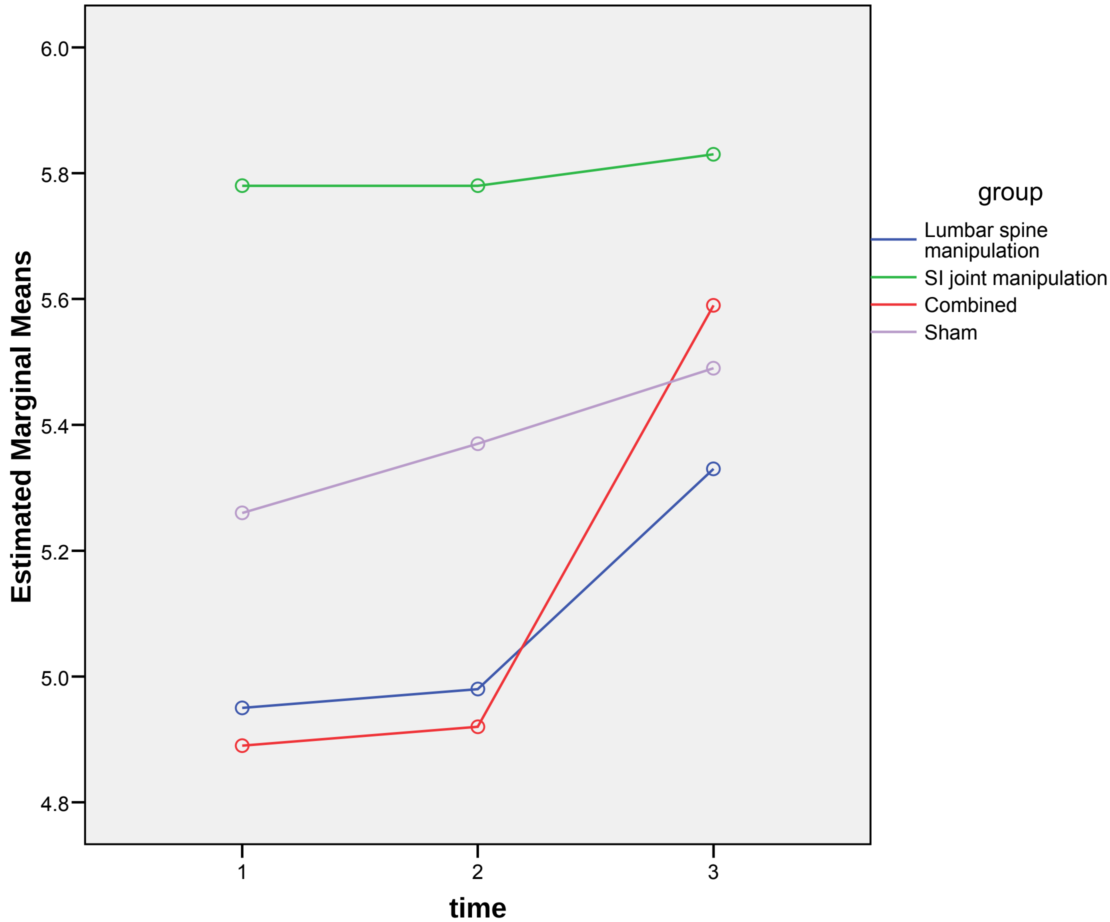


Figure 4.14 Graph Showing Inter-Group Lumbar Left Lumbar Rotation Comparison

4.4.5.6 Lumbar Right rotation

There was a statistically significant difference in the treatment groups effects over time (p = 0.012). The figure shows that the combined and lumbar manipulation groups showed a greater response than the other groups.

Table 4.15 Inter-group Lumbar Right Rotation Comparison

Effect	Statistic	*p value*
Time	0.458	< 0.001
Time*Group	0.633	0.012
Group	2.688	0.061

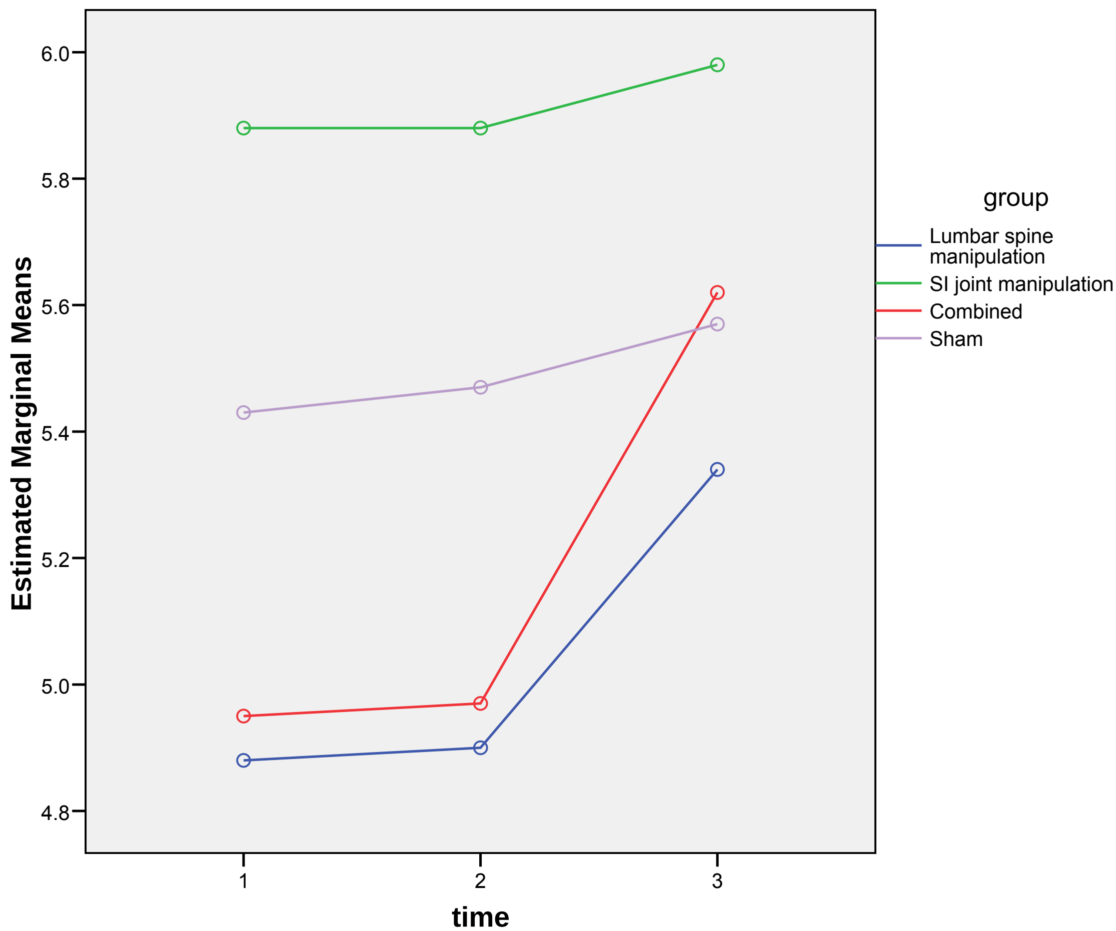


Figure 4.15 Graph Showing Inter-Group Lumbar Right Lumbar Rotation Comparison

4.4.5.7 Left SI Flexion Measurement 1

While the figure shows a trend towards a higher rate of improvement in the combined lumbar and SI manipulation groups, the difference was not statistically significant.

Table 4.16 Inter-group Left SI Flexion 1 Comparison

Effect	Statistic	*p value*
Time	0.810	0.025
Time*Group	0.768	0.148
Group	0.269	0.847

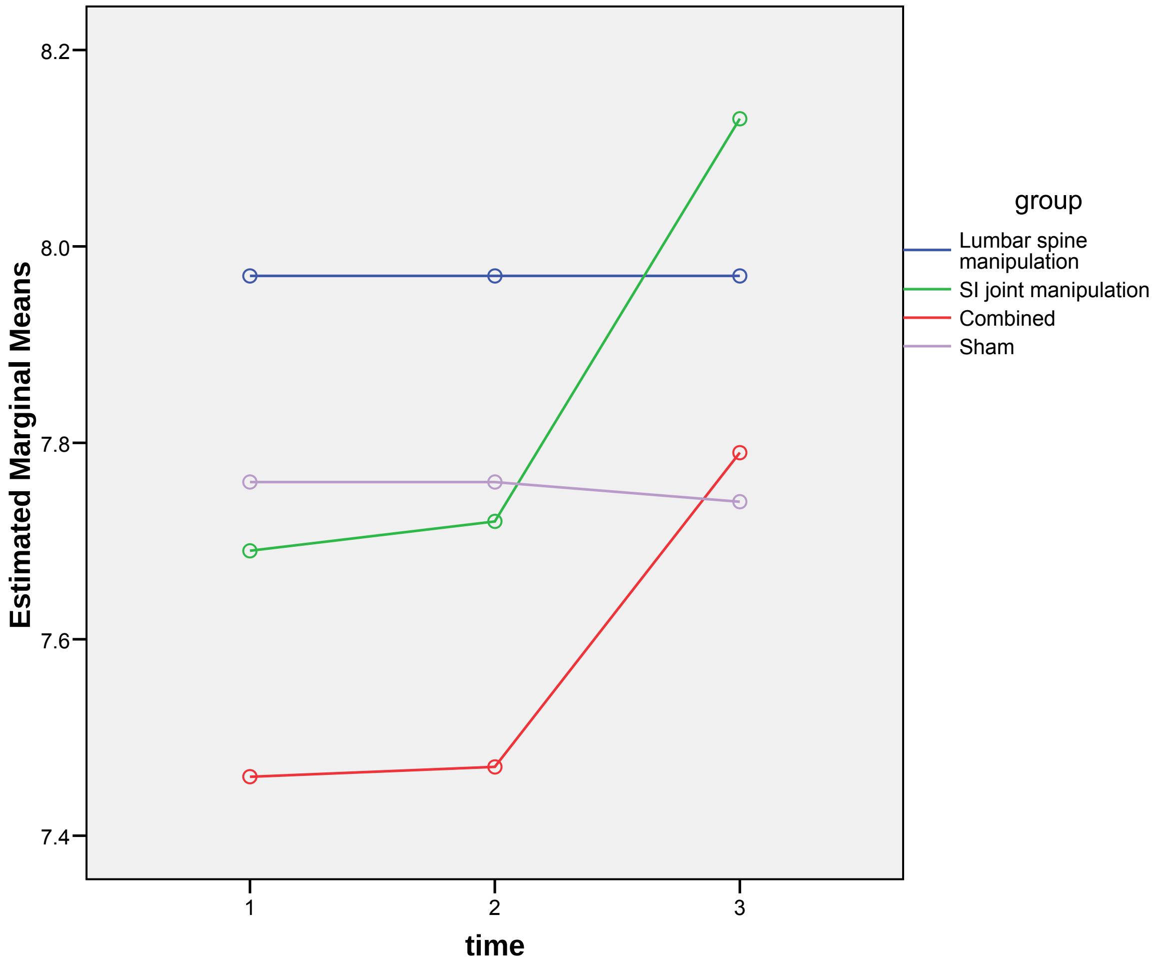


Figure 4.16 Graph Showing Inter-Group Left SI Flexion 1 Comparison

4.4.5.8 Left SI Flexion Measurement 2

There was a statistically significant difference between effects of the four different treatment groups (*p* = 0.042). The SI manipulation group and combined groups had the most successful outcomes.

Table 4.17 Inter-group Left SI Flexion 2 Comparison

Effect	Statistic	*p value*
Time	0.862	0.022
Time*Group	0.799	0.042
Group	0.231	0.874

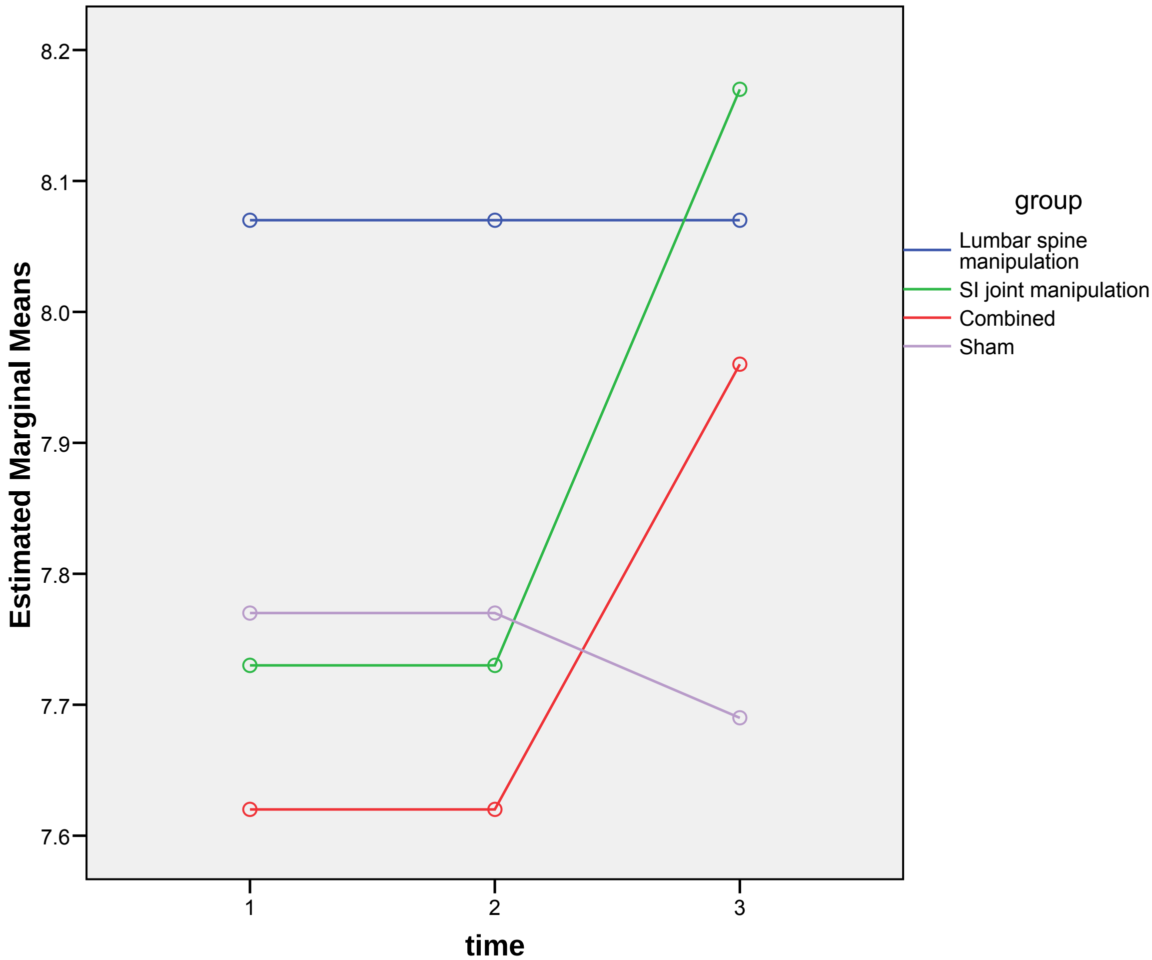


Figure 4.17 Graph Showing Inter-Group Left SI Flexion 2 Comparison

4.4.5.9 Right SI Flexion Measurement 1

While the figure shows at trend towards a higher rate of improvement in the combined and SI manipulation groups, the difference was not statistically significant.

Table 4.18 Inter-group Right SI Flexion 1 Comparison

Effect	Statistic	*p value*
Time	0.777	0.012
Time*Group	0.729	0.078
Group	0.941	0.431

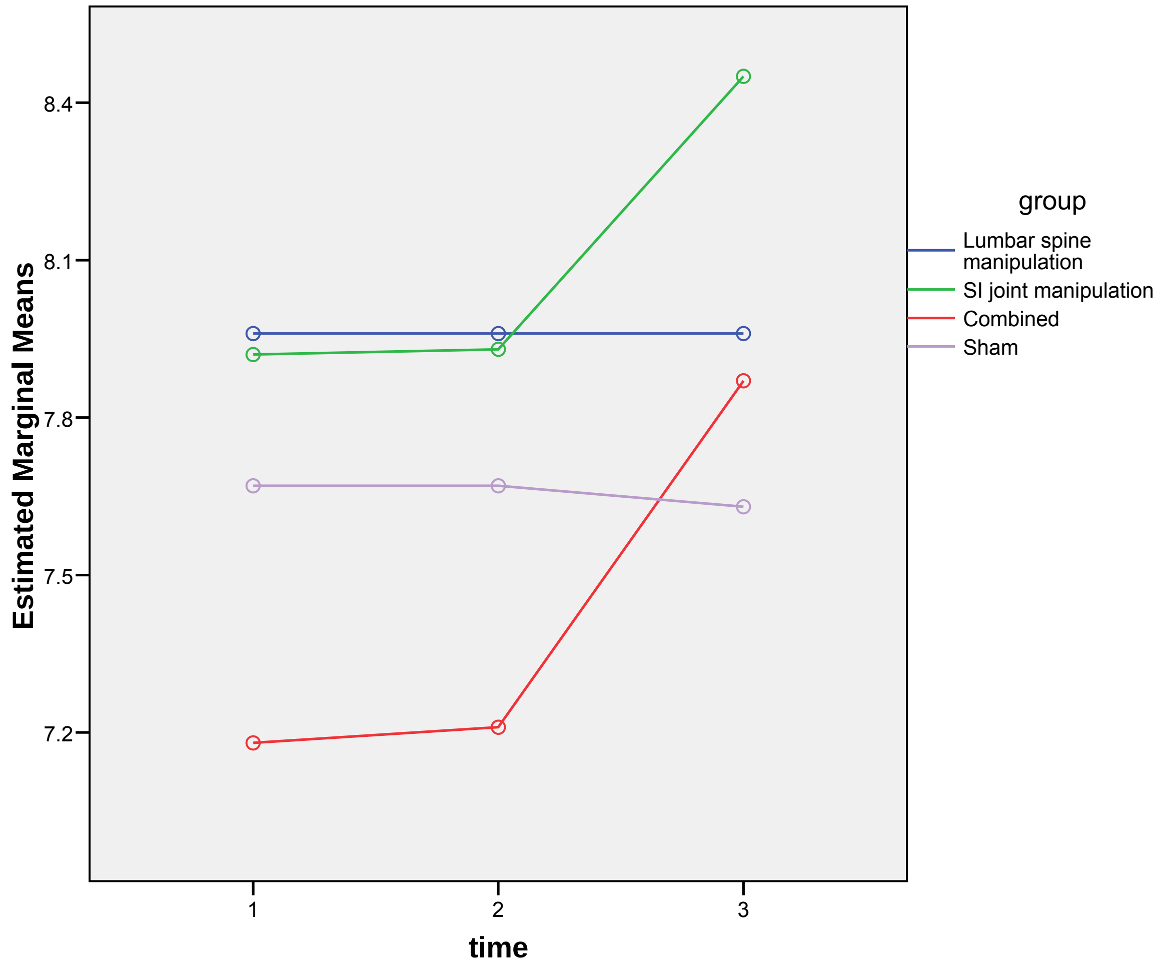


Figure 4.18 Graph Showing Inter-Group Right SI Flexion 1 Comparison

4.4.5.10 Right SI Flexion Measurement 2

There was a statistically significant difference between effects of the four different treatment groups (*p* = 0.017). The SI manipulation group and combined groups had the most successful outcomes.

Table 4.19 Inter-group Right SI Flexion 2 Comparison

Effect	Statistic	*p value*
Time	0.760	0.008
Time*Group	0.652	0.017
Group	0.677	0.572

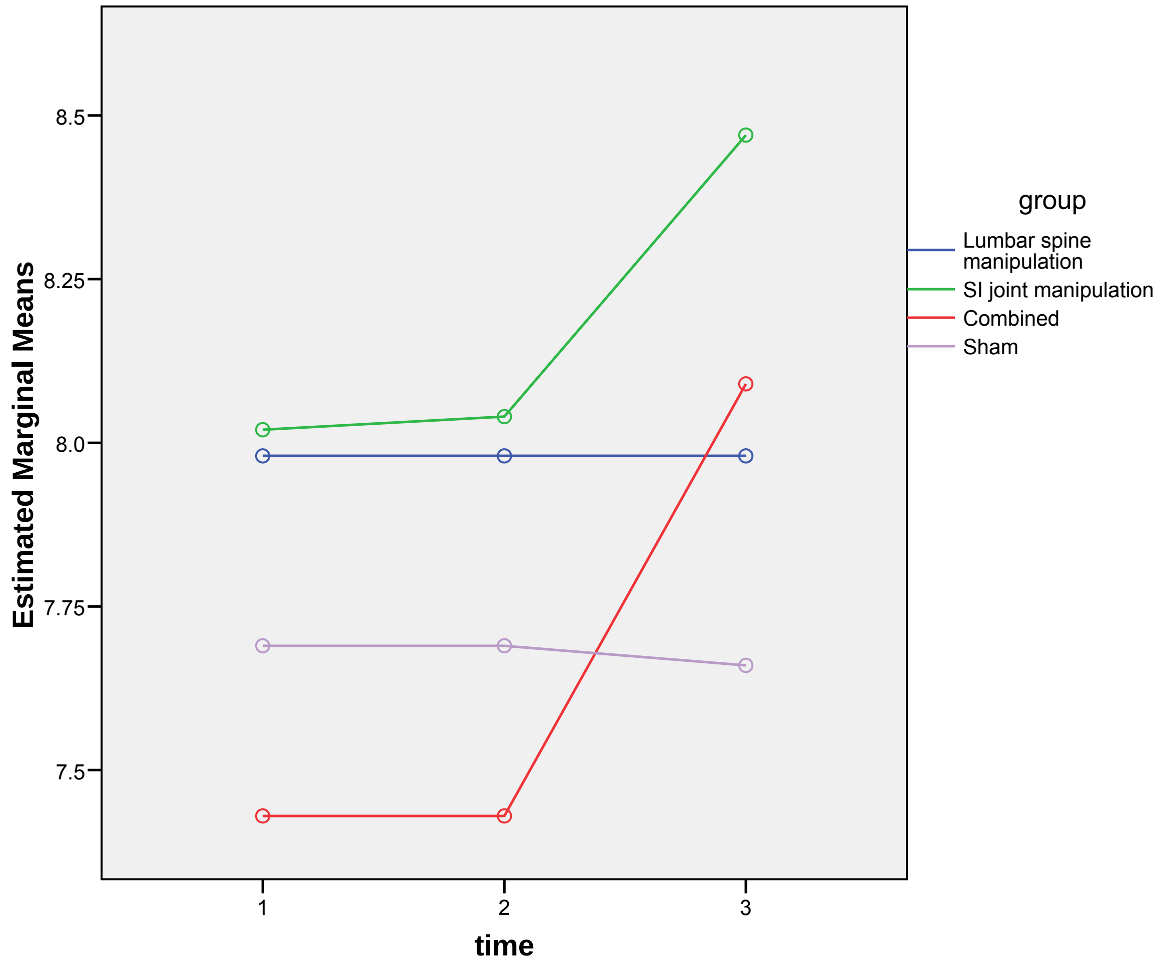


Figure 4.19 Graph Showing Inter-Group Right SI Flexion 2 Comparison

4.4.5.11 Average Kicking Speed

All three treatment groups were better than the sham group for average kicking speed. The combined group achieved the highest rate of improvement.

Table 4.20 Inter-group Average Kicking Speed Comparison

Effect	Statistic	*p value*
Time	0.417	< 0.001
Time*Group	0.485	< 0.001
Group	0.349	0.790

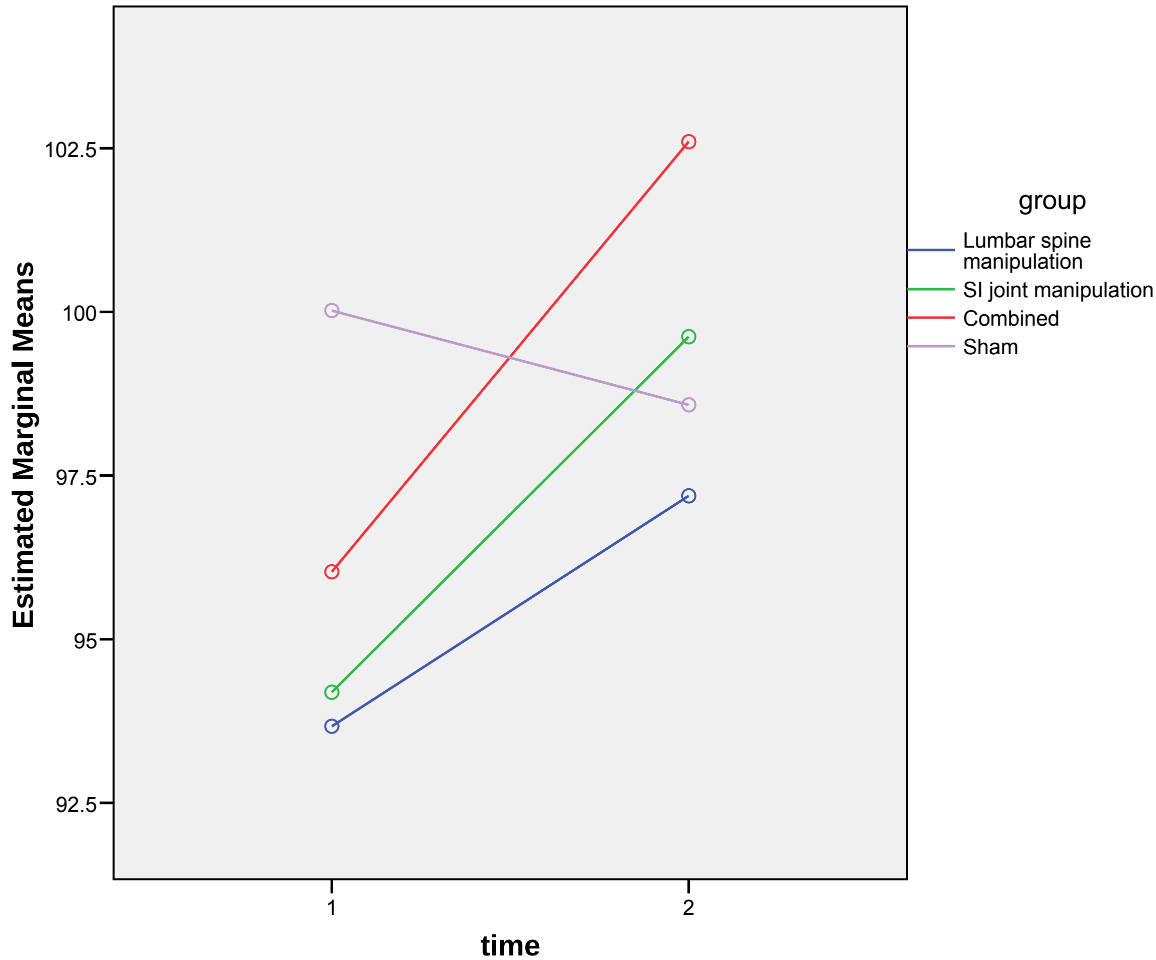


Figure 4.20 Graph Showing Inter-Group Average Kicking Speed Comparison

4.4.5.12 Maximum Kicking Speed

All three treatment groups were better than the sham laser group for kicking speed 2. However, the combined group achieved the highest rate of improvement.

Table 4.21 Inter-group Maximum Kicking Speed Comparison

Effect	Statistic	*p value*
Time	0.592	< 0.001
Time*Group	0.586	< 0.001
Group	0.330	0.804

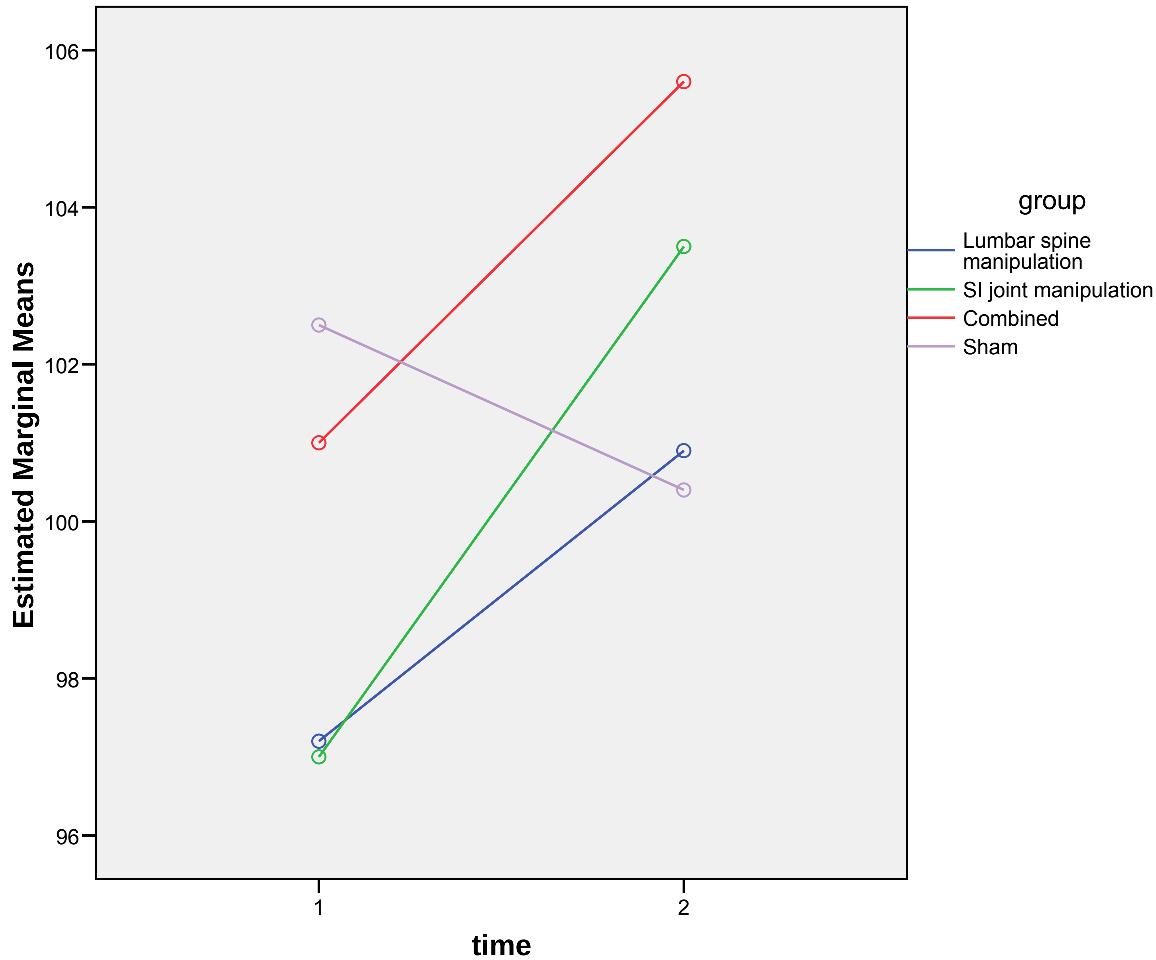


Figure 4.21 Graph Showing Inter-Group Maximum Kicking Speed Comparison

4.4.6 Objective Six

To determine the association between the change in kicking speed pre and post intervention and the subjects' perception of the change in kicking speed.

Table 4.22: Cross Tabulation of Subjective Change and Objective Change in Average Kicking Speed

			Objective Change in Kicking Speed (avg.)			Total
			Decrease	Same	Increase	
Subjective Change in Kicking Speed	Decrease	Count	1	0	0	1
		%	100.0%	.0%	.0%	100.0%
	Same	Count	6	2	6	14
		%	42.9%	14.3%	42.9%	100.0%
	Increase	Count	1	0	24	25
		%	4.0%	.0%	96.0%	100.0%
Total		Count	8	2	30	40
		%	20.0%	5.0%	75.0%	100.0%

p = 0.001

Table 4.23: Cross Tabulation of Subjective Change and Objective Change in Maximum Kicking Speed

			Objective Change in Kicking Speed (max)			Total
			Decrease	Same	Increase	
Subjective Change in Kicking Speed	Decrease	Count	1	0	0	1
		%	100.0%	.0%	.0%	100.0%
	Same	Count	7	0	7	14
		%	50.0%	.0%	50.0%	100.0%
	Increase	Count	1	1	23	25
		%	4.0%	4.0%	92.0%	100.0%
Total		Count	9	1	30	40
		%	22.5%	2.5%	75.0%	100.0%

p = 0.005

There were significant associations between subjective and objective changes in kicking speed for both average and maximum speed. However, due to many zero value cells in the tables, some statistical tests are not valid. This came about due to very few actual objective "same" scores since this required the difference between the speeds to be zero. Therefore, most people who rated their change as "same" actually achieved equal probability of an increase or a decrease. Those who rated their change as increase mostly did actually increase. Only one person subjectively rated a decrease and that person did actually decrease.

CHAPTER FIVE

DISCUSSION

5.1 INTRODUCTION

This chapter will discuss the results from Chapter Four in terms of the surrounding literature.

5.2 DEMOGRAPHIC DATA AND PHYSICAL CHARACTERISTICS

There were no statistically significant differences between the four groups in terms of age, height and weight. However, in the combined manipulation group, higher mean height and weight measurements were noted as shown in **Table 4.1**. Due to the similar means in the demographic data of the subjects, any bias towards a particular group potentially present was eliminated. It is relevant that there is no significant difference in demographics between groups because, as discussed by Kellis and Katis, (2007), the subjects' age, experience level and physical size are all factors that could affect kicking speeds. The demographics of the subjects' in this study are aligned with the subjects' demographics used in the studies included in **Table 2.3** in terms of age, gender and experience level. This fact would thus render the results of this study equally relevant to the subjects in the studies mentioned in **Table 2.3**.

5.3 ROM FINDINGS

5.3.1 Discussion on the ROM Findings Post Intervention for Groups 1, 2 and 3

In Group 1, the lumbar manipulation was shown to be effective in improving both left and right lumbar rotation as the results were statistically significant **(Table 4.2)**. These results are expected due to the rotary nature of the lumbar roll technique used in the manipulation (Szaraz, 1990) and the effect of a manipulation on ROM noted by Gatterman, (2003). Similarly Kruger, (1999); Myburgh, (1998) and Sood, (2008), achieved increased ROM post-manipulation in their respective research.

In Group 2 there was no statistically significant effect of the SI joint manipulation noted on both lumbar and SI ROM tests **(Table 4.4)**. However, ROM of the SI joints has been found to be very small (Cohan, 2005), so the increase of ROM post manipulation is small, in comparison to lumbar joint ROM increase, and although statistically insignificant, may still have had a cumulative impact in the increase in kicking speed. This cumulative impact is explained using the following reasoning. The involvement of the SI joint in the kicking action, as mentioned in Section 2.5, relies on the maximum motion of this joint to be utilised. The small increase in ROM could still have an effect on the resultant kicking speed, post intervention, by increasing the swinging limb distance. Increased motion at the SI joint would allow for increased swing limb distance and therefore increasing the ability of the kicking limb to create a greater momentum through the kicking action.

The SI flexion 2 ROM measurements for all Groups showed larger increases in SI flexion ROM when compared to the SI flexion 1 measurements. Due to the nature of the SI flexion 2 ROM measurements this may be due to an increased hip flexion ability following an SI manipulation or due to inaccuracy in practitioner palpation with regards to initiation of SI motion (see the tests described in Section

3.6.2). The ROM measurements were performed by the researcher and overseen by a clinician, which would therefore have reduced or minimised the chance of operator induced error as there were two practitioners doing the palpation.

The results for Group 3 **(Table 4.6)**, showed that combined lumbar spine and SI joint manipulations rendered significant effects on lumbar extension, left and right lumbar rotation and right SI flexion (measurement 2) ranges of motion. The improved extension findings are in agreement with the results of the research performed by Bicalho *et al.,* (2010), which revealed that a positive effect on extension motions of the lumbar spine with a concurrent decrease in paraspinal muscle stiffness occurred as result of the manipulation. The p value for left SI ROM was 0.052, which is slightly above the statistical significance value of $p < 0.05$ **(Table 4.6)**. This shows that a greater increase in ROM was found in subjects receiving right sided SI joint manipulation when compared to those subjects receiving left sided SI joint manipulation and this could be due to the following:

- Excellent joint response to the manipulation within the subjects receiving right sided manipulation. This could be due to a good or better manipulation technique used by the researcher when receiving a right sided SI joint manipulation.
- Poor joint response to the manipulation within the subjects receiving left sided manipulation. This may be due to a poorer manipulation technique used by the researcher when performing a left sided SI joint manipulation.
- When performing the left sided SI manipulation technique when compared to that of the right sided manipulation, the researcher may have had a particular side of preference due to his side of dominance.

Human error may have occurred in data collection due to minor movements of the SI joints and the incorrect palpation of motion initiation and cessation of the SI joint. This may have occurred slightly in all readings, and in all groups, as the inclinometer is operator dependant. With a sample size of ten subjects per group, a poor response to a manipulation on either side by just one subject may affect whether or not the means values are rendered statistically significant or not. Therefore, it is suggested that future research consider increasing the numbers of subjects per group. It may also be possible that the inclinometer was not sensitive enough to detect the changes in the SI joint movement, thus not reflecting the change as being statistically significant. It is recommended that in future research changes in SI joint movement be reflected in percentage format so as to magnify the chance of demonstrating a statistical significance. Greater measurement tool sensitivity may also have resulted in greater numerical difference between the pre and post adjustment measurement.

The possible reasons as to why there were greater SI ROM changes in the combined manipulation intervention as opposed to the SI joint manipulation could be one or a combination of the following:

- Increased neurological stimulus due to multiple vertebral level manipulation. Increased neurological stimulus would increase nerve and muscle firing, as well as proprioception, within structures supplied by the nerves affected by the manipulation (Redwood, 2003).
- The increased number of cavitations experienced by the subjects in this group could improve their response to the treatment by psychological means therefore increasing the placebo effect (Maigne and Vautravers, 2003).
- The positive effect of lumbar manipulation on muscle tension in muscles attaching from the lumbar spine to the pelvis, therefore allowing for greater ROM at the SI joints (Bicalho *et al.,* 2010).

Subjects in this group receiving left lumbar and right SI manipulations or vice versa could biomechanically respond greater to this intervention due to the effect of the manipulation of joints on both sides (Pickar, 2002).

5.3.2 Discussion on the ROM Findings Post Sham Laser Intervention for Group 4

The sham laser intervention showed no significant statistical effect on any of the ROM tests performed **(Table 4.8)**. This result is expected as the subjects are not receiving any form of physiologically altering treatment (McConnell and Philipchalk, 1992).

5.3.3 Summary

Groups 1 and 3 both showed a significant increase in rotation movements. The SI joint ROM only improved in the combination manipulation Group, whereas the sham laser Group 4 did not respond in ROM. When compared, it was clear that these groups performed better than that receiving the sham laser intervention. This indicates that any improvement in these groups are intervention related and not due to the possibility of increased reporting of findings by the research subjects or researchers.

In all subjects, it was noted that ROM in all directions were very slightly increased but never statistically significantly increased post warm-up. See **Figures 4.1, 4.3, 4.5, 4.7** for these results. A lack of response is in keeping with the research performed by Young *et al.,* (2004), on the effect of static stretching on ROM. This result demonstrates that, in this study, manipulation was a more effective intervention in increasing the ROM of the lumbar spine and the SI joints when compared to the warm-up procedure used **(Appendix, H)**.

The inclinometer device is operator dependant and although reported error is minimal in other studies there is still room for human error (Mayer *et al.,* 1997). ROM movements performed by the subjects are entirely subjective and the placebo/Hawthorne effect could come into play. The audible cavitations could increase the response of the subject to the intervention, by increasing the psychological response (Wilder, Pope and Frymoyer, 1988).

The results discussed above reject the Null Hypotheses (Ho) stated in Section 1.3.2, for Groups 1, 2 and 3, regarding the change in ROM post intervention of the lumbar spine and SI joint. The Null Hypothesis is accepted for the results of Group 4.

5.4 LUMBAR SPINE ROM DISCUSSION

5.4.1 Inter-Group Discussion on the Findings of Lumbar Flexion

There was no difference between the four interventions on lumbar spine flexion over time ($p = 0.183$). The figure shows that while there was some improvement in the combined and lumbar spinal manipulation Groups (1 and 3), the effect was small and not different to Groups (2 and 4) which showed no change over time.

5.4.2 Inter-Group Discussion on the Findings of Lumbar Extension

There was a differential treatment effect in the four groups ($p = 0.003$). The **Figure 4.11** shows that it was the combined Group which showed the greatest effect for extension. Research performed by Bicalho *et al.* (2010), showed that lumbar manipulation had a positive effect on extension motion of the lumbar spine, i.e. increasing motion, with a concurrent decrease in paraspinal muscle stiffness. The decrease in paraspinal muscle stiffness could explain the increased extension ability of the lumbar spine, but this increase may also be as a direct result of the lumbar manipulation (Pickar, 2002). The increased ROM in the SI joints, combined with the increased lumbar ROM, following SI joint and lumbar manipulation could allow for more extension motion in the lumbar spine. This theory, along with the increased neurological firing post manipulation (Pickar, 2002), could be the reason why lumbar extension motion was only increased post intervention in the combination group.

5.4.3 Inter-Group Discussion on the Findings of Lumbar Lateral Flexion (Left and Right)

While **Figures 4.12** and **4.13** show a trend towards a higher rate of improvement in the combined and lumbar spine manipulation Groups, the difference was not statistically significant. The lumbar manipulation performed was a rotational adjustment (Szaraz, 1990) and thus a statistically significant improvement in the lateral flexion ROM is not expected.

5.4.4 Inter-Group Discussion on the Findings of Lumbar Rotation (left and Right)

There was a statistically significant difference in the treatment Groups' effects over time ($p = 0.001$). The **Figures 4.14** and **4.15** show that the combined lumbar spine and SI joint manipulation Group fared better than the other Groups. This is expected due to the rotary nature of the manipulation technique used as described by Szaraz (1990).

5.4.5 Summary

The rotary nature of the lumbar spine manipulation used, coupled with slight extension (Szaraz, 1990), lends itself to the above results where the only statistically significant differences were noted in the rotation and extension motions during inter-group comparisons.

5.5 SACROILIAC JOINT ROM DISCUSSION

5.5.1 Inter-Group Discussion for Left and Right SI Flexion (Measurement 1)

While **Figures 4.16, 4.17, 4.18** and **4.19** show a trend towards a higher rate of improvement in the combined lumbar spine and SI joint manipulation Group, the difference was not statistically significant. As mentioned in Section 5.3.1, the second SI ROM measurement technique was noted in all Groups to be more sensitive to the changes in ROM. This may be due to the limb motion and increased muscular involvement in this measurement technique, or due to operational errors on behalf of the practitioner. The two different methods, although both aim to measure the SI joint ROM, are completely different and thus results are not expected to concur exactly (see the tests described in Section 3.6.2).

5.5.2 Inter-Group Discussion for Left and Right SI Flexion (Measurement 2)

There was a statistically significant difference between effects of the four different treatment Groups (p = 0.042). The SI manipulation group and combined group had the most successful outcomes. This result is expected due to the fact that SI joint manipulation is only involved in these two treatment groups. When the results of the manipulation groups were compared to that of the sham laser group, it was noted that the sham laser group was least effective in increasing SI ROM.

5.5.3 Summary

Statistically significant changes in findings were only noted post intervention by the second SI ROM measurement technique. This technique was noted, in all Groups, to be more sensitive to the changes in ROM. It may be possible that the inclinometer was not sensitive enough to detect the changes in the SI joint movement, or the ROM tests used may not have been specific enough, thus not reflecting the change as being statistically significant. ROM of the sacroiliac joints is very small so the increase of ROM post manipulation is small, in comparison to lumbar joint increase, and although statistically insignificant, there was a statistically significant increase in kicking speed.

5.6 KICKING SPEED FINDINGS

The kicking speeds of subjects in the literature **(Table 2.3)** ranged between 18.51m/s (66.64 km/h) - 29.8m/s (107,28 km/h). The means of the average and maximum kicking speeds noted in the current study ranged between 93.6 km/h-102.2 km/h and 95.5 km/h- 105.5 km/h respectively **(Tables 4.3, 4.5, 4.7, 4.9)**. The slower speeds noted in **Table 2.3** were as a result of either a shorter run-up, an angle restricted run-up or because of the use of amateur subjects. Dørge *et al.,* (2002), using the most similar restrictions to the run-up of the kicking action when compared to those used in this study, with a restricted run-up distance of 3meters and no run-up angle restriction, recorded kicking speeds of 24.7m/s (88.92km/h). This is slightly below the readings recorded in this study, however Dørge *et al.,* (2002) used 'skilled' subjects which may have been of a lower ability when compared to the players (regional premier league players or higher) used in this study. The differences recorded may also be due to a different playing surface, as for the current study, the ball was kicked on an astroturf surface. Overall it can be seen that the kicking speeds recorded in this study do fall into the range of kicking speeds recorded in the literature.

5.6.1 Discussion on the Kicking Speed Findings Post Intervention for Groups 1, 2 and 3

As displayed in **Table 4.3**, the lumbar manipulation intervention of Group 1 had a positive influence (increasing speeds) on both the average and maximum kicking speeds with a p value of 0.009 and 0.029 respectively. **Figure 4.2**, illustrates that both the mean average and mean maximum kicking speeds improved by ± 4km/h. These findings are in agreement and support the results found in similar research conducted by Fox (2006) and Sood (2008). The biomechanical (Kellis and Katis, 2007) and possible neurological role of the lumbar spine does affect the instep kicking technique, the typical biomechanical response resulting from a lumbar spine manipulation (Herzog, 2000; Pickar, 2002; Gatterman, 2003), which would potentially increase resultant kicking speed is confirmed by the results of this study.

As displayed in **Table 4.5**, the SI joint manipulation intervention of Group 2 had a highly influential effect in increasing both the average and maximum kicking speeds with the same *p* value of 0.001. **Figure 4.4** shows that the mean average kicking speed increased by ± 6 km/h and the mean maximum kicking speed improved by ± 7km/h. Due to the involvement of the SI joint in the instep kicking technique, explained in Section 2.3.2, the typical response of a joint and the surrounding tissues following a manipulation (Herzog, 2000; Pickar, 2002 Gatterman, 2003) and along with findings in research performed by Suter, McMorland, Herzog, and Bray (2000) and Fox (2006), stating that SI joint manipulation improved knee extension ability, this increased kicking speed is expected and confirmed by the results.

The SI joint is richly innervated by the anterior primary divisions of nerves L2 - S2, and these same nerves supply stimulation to the femoral and tibial nerves (Suter, McMorland, Herzog and Bray, 2000; Cohan, 2005). Therefore with the increased neuronal stimulation and nervous response as a result of the SI joint manipulation, there could theoretically be a ripple effect in terms of an increased firing of all the nerve endings originating from L2 - S2 (Pickar, 2002). With the nerve supply to the majority of the muscles of the lower limb originating from these levels (Moore and Dalley, 2005; Williams *et al.*, 2005), (provided the increased stimulation occurs along the nerve), the neurological effect of the SI joint manipulation on the lower limb biomechanical chain should be positive (Pickar, 2002).

As displayed in **Table 4.7**, the combination of the lumbar manipulation and the SI joint manipulation intervention of Group 3 had a highly significant influence on both the average and maximum kicking speeds with a p value of < 0.001 and 0.002 respectively. **Figure 4.6** shows that the mean average kicking speed increased by ± 7 km/h and the mean maximum kicking speed improved by ± 5km/h. The reasons discussed above for the increase in kicking speeds in Groups 1 and 2 can similarly be combined and used as an explanation for the increased kicking speeds observed and stated in **Table 4.7** and **Figure 4.6** post intervention in Group 3. With more than one manipulation being performed in this Group, subjects in this Group receiving left Lumbar and right SI manipulations or vice versa could biomechanically and neurologically respond better to this intervention, due to the effect of the manipulation on bodily tissues, (Pickar, 2002), bilaterally.

5.6.2 Discussion on the Kicking Speed Findings Post Sham Laser Intervention for Group 4

As displayed in **Table 4.9**, the sham laser intervention of Group 4 had no statistically significant influence on both the average and maximum kicking speeds with a p value of < 0.070 and 0.096 respectively. **Figure 4.6** shows that the mean average kicking speed decreased by ± 1.5 km/h and the mean maximum kicking speed decreased by ± 2 km/h. These findings are expected as the subjects are not receiving a valid treatment protocol. However, these findings are beneficial to the study as a decrease in the kicking speed, post sham laser intervention, makes the increased kicking speed result post manipulative intervention that much stronger.

5.6.3 Summary

Statistically significant increases in kicking speeds were reflected in all three manipulative Groups, with the sham laser intervention showing little or a negative effect post intervention **(Table 4.3**, **4.7** and **4.9)**.

Although the neurological effect of the manipulation was not measured in this study, it could have played a role in the positive results obtained. Increased neurological stimulation following manipulation, as reported by Pickar (2002), could increase muscular contraction ability of the effected musculature, resulting in an increased limb swinging speed and thus resultant kicking speed.

Due to the fact that in all four Groups the subjects were aware that they were being studied, the full effect of the Hawthorne principles were not measurable (McCarney *et al.,* 2007). However, because the post intervention kicking speeds in Group 4 (the placebo group) were not statistically significant, and the post intervention kicking speeds in the other 3 groups were statistically significant, it can be deduced that the increase in kicking speed post intervention for Groups 1, 2 and 3 was due to the intervention and not due to the Hawthorne effect.

With the increased kicking speed noted in Groups 1, 2 and 3, the Null Hypothesis stated in Section 1.3.1, regarding increased kicking speed post intervention, can be rejected. However this Null Hypothesis is accepted for Group 4.

The combined results of the increase in ROM and increased kicking speed reject the Null Hypothesis, as stated in Section 1.3.1, that there would be no correlation between the changes in kicking speed and ROM immediately post intervention.

5.7 DISCUSSION ON AVERAGE AND MAXIMUM KICKING SPEED

As per **Table 4.20** and **Figure 4.19,** all three manipulation treatment Groups demonstrated to be more effective than the Sham laser Group in increasing average kicking speed. The lumbar spine and SI joint combination manipulation Group achieved the highest rate of improvement followed by the SI joint manipulation and then lumbar spine manipulation Groups. According to Sterzing and Henning, (2007) any increase in average and maximum kicking speed is beneficial to all soccer players because of the following benefits:

- Increased kicking distance. Given the right trajectory, the ball will travel further. This is very important for goalkeepers where maximum distance is required from goal kicks.
- When a player shoots at goal it will give the goal keeper less time to react and therefore increasing the player's chances of scoring.
- Faster passes would make it harder for the defending team to get to the ball.

5.8 SUBJECTS PERCEPTION OF THE CHANGE IN KICKING SPEED

From **Table 4.22,** it is visible that the majority of the subjects' perception was that the kicking speed had increased following the intervention. The perception of increase was matched with 96% of the subjects actually increasing the average kicking speeds and 92% increasing the maximum kicking speeds post intervention. This high correlation between subjects' perception and objective results is a positive sign, and could be due to one of the following:

1. Post intervention, the majority of subjects commented saying that they felt much "looser" and that the kicking technique felt a lot smoother. This would directly result from the effects of manipulation (Herzog, 2000; Pickar, 2002 and Gatterman, 2003).

2. Maigne and Vautravers (2003) suggested that this change in perception could be due to the physical contact and interaction as well as the sound of the cavitation and the association of the sound with the perception that the vertebrae is being correctly repositioned.

Only one subject perceived a decrease post intervention and this agreed with the average and maximum kicking speeds of this subject. The subject who perceived this decrease formed part of the sham laser intervention group. This indicates that there were no subjects that perceived their kicking action and speed to be slower post manipulative intervention.

There is, therefore, a statistically significant association between changes in kicking speeds immediately post intervention and the subjects' perception of change in kicking speed, thus rejecting the null hypothesis stated in Section 1.3.4.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSION

The three manipulative intervention Groups demonstrated to be more effective than the Sham laser Group in increasing average kicking speed. The lumbar spine and SI joint combination manipulation Group achieved the highest rate of improvement followed by the SI joint manipulation and then lumbar spine manipulation Groups. According to Sterzing and Henning, (2007) any increase in average and maximum kicking speed is beneficial to all soccer players.

The objectives identified for this study included:

- To determine the immediate effect (pre and post intervention) of lumbar spine manipulation on the lumbar ROM and the kicking speed in soccer players, in terms of the subjective and objective measurements.

- To determine the immediate effect (pre and post intervention) of sacroiliac joint manipulation on the sacroiliac ROM and the kicking speed in soccer players, in terms of the subjective and objective measurements.

- To determine the immediate effect (pre and post intervention) of a combination of lumbar spine and sacroiliac joint manipulation on the lumbar spine and sacroiliac joint ROM and the kicking speed in soccer players, in terms of the subjective and objective measurements.

- To determine the immediate effect (pre and post intervention) of sham laser technique on the lumbar spine and sacroiliac joint ROM and the kicking speed in soccer players, in terms of the subjective and objective measurements.

- To compare the subjective and objective measures for all groups.

- To determine the association between the change in kicking speed pre and post intervention and the subjects' perception of the change in kicking speed.

With regards to the objectives of the study:

- There was no significant effect of the SI joint manipulation on ROM, however a significant increase in kicking speed was noted post intervention.
- There was a significant change in the lumbar spine rotation and extension ranges of motion as well as the kicking speed post intervention.
- There was no effect noted on lumbar spine and SI joint ROM, as well as kicking speed post sham laser intervention.
- There was a strong association between subjects' perception of change in actual kicking speed, and actual change in kicking speed.

The Null Hypotheses (Ho) for this study were set as follows:

- There would be no statistically significant increases in kicking speed post intervention for any of the four groups.
- There would be no statistically significant increases in ROM for any of the four groups.
- There would be no statistically significant correlation between change in kicking speed immediately post intervention and change in ROM of the lumbar spine and / or the sacroiliac joint.

- There would be no statistically significant association between change in kicking speeds immediately post intervention and the subjects' perception of change in kicking speed.

With regards to the Null Hypotheses of this study:

- Statistically significant increases in kicking speeds were noted in all manipulative intervention groups, thus rejecting the null hypothesis for all manipulative groups. The null hypothesis was accepted for the sham laser intervention group.
- Statistically significant increases in ROM were noted post intervention of groups 1 and 3, therefore rejecting the null hypothesis for these groups, however the null hypothesis was accepted for groups 2 and 4.
- A statistically significant correlation was noted between the change in kicking speed immediately post intervention and change in ROM of the lumbar spine and / or the sacroiliac joint post intervention, thus rejecting the null hypothesis.
- There was a strong association between subjects' perception of change in actual kicking speed, and actual change in kicking speed post intervention, thus rejecting the null hypothesis.

6.2 RECOMMENDATIONS

The sample size of this study was limited to forty subjects. This very small sample groups results were interpreted via the use of a statistical package, which yielded statistically significant results, but trends observed within the study may allow for recommendations of a larger sample size for future studies as this would reduce the risk of having a Type Two error.

Similar studies should be performed in the future assessing the impact of SI joint and lumbar spine manipulation on subjects, in terms of neurological verses ROM response to the manipulation and the resultant effect on kicking speed. This serves to ascertain if the manipulation has a greater effect on increasing ROM thus increasing kicking speed or if the manipulation increased the proprioceptive awareness of the subject and hence produced an increased kicking speed post manipulation.

Inclusion criteria could have been more specific targeting professional football players. Reason being their kicking technique is more refined, which produces more consistency and accuracy during the kicking motion. The small alterations made during each kicking action by semi-professional soccer players may have produced variables.

The run-up distance and run-up speed has a large effect on the resultant speed of the ball due to the momentum of the body through the ball (Kellis and Katis, 2007). For this reason the average and maximum kicking speeds were both controlled to a degree by placing a limit on the run-up of the subject. All subjects were given a 3 meter run-up to limit the effect of run-up speed on the final kicking speed. A study showing the correlation between the run-up speeds on kicking speed should be performed to quantify the effect the run-up speed has on kicking speed. This study could also include the effect of the run-up angle on the resultant speed of the kick.

There is room for a position specific, kicking speed, comparison study in which the subjects are grouped according to their field positions. The fixations noted as well as the kicking speeds may differ according to their position.

Subjects in Group 3 that received contra lateral lumbar spine and sacroiliac joint manipulations, could have responded better biomechanically to manipulation due to the effect of the manipulation on the joints and surrounding anatomy (Pickar, 2002). A comparative study on the difference in the effects of ipsilateral and contra lateral manipulation of the lumbar spine and sacroiliac joints on kicking speed could therefore be an interesting topic to study.

Judging by the results obtained on SI joint ROM it may also be possible that the inclinometer was not sensitive enough to detect the changes in the SI joint movement, or the ROM tests used may not have been specific enough, thus not reflecting the change as being statistically significant. It is recommended that in future research changes in SI joint movement be reflected in percentage format so as to magnify the chance of demonstrating a statistical significance.

Examiner reliability studies should be performed on the usage of the Saunders digital inclinometer during lumbar spine and SI joint ROM movements.

It is recommended that further research on the effect of manipulation of the joints of the lower biomechanical chain, involved in the kicking action, on the kicking speed of the subjects be performed. This recommendation would add to this study in that it would show, to which joint, the manipulation is of greatest effect as a tool to increasing kicking speed.

REFERENCES

Aldous, S. 2003. The Sacroiliac Joint. [online] Available from: http://www.vancouveryoga.com/anatomy_sacroilliac.html [Accessed 29 October 2010].

Arab, A, Abdollahi, I, Joghataei, M, Golafshani, Z and Kazemnejad, A. 2009. Inter- and Intra-examiner Reliability of Single and Composites of Selected Motion Palpation and Pain Provocation Tests for Sacroiliac Joint. *Manual Therapy*; 14: 213-221.

Barfield, W, Kirkendall, D and Yu, B. 2002. Kinematic Instep Kicking Differences Between Elite Female and Male Soccer Players. *Journal of Sports Science and Medicine*; 1: 72-79

Bergmann, T, Peterson, D and Lawrence D. 1993. *Chiropractic Technique*. Churchill Livingstone Inc.

Bicalho, E, Setti, J, Macagnan, J, Cano, J, and Manffra, E. 2010. Immediate Effects of a High-Velocity Spine Manipulation in Paraspinal Muscles Activity of Nonspecific Chronic Low-Back Pain Subjects. *Manual Therapy*; 15:469-475

Bir, C, Cassatta, J and Janda, D. 1995. An Analysis and Comparison of Soccer Shin Guards. *Clinical Journal of Sports Medicine*; 5(2):95-9.

Cohan, S. 2005. Sacroiliac Joint Pain: A Comprehensive Review of Anatomy, Diagnosis, and Treatment. *Anaesthesia Analgesia*; 101:1440 –53

Darby, S.A, Cramer, G. D. 1995. *Basic and Clinical Anatomy of the Spine, Spinal Cord, and ANS.* Mosby-Year Book, Inc.

Dørge, H., Bull Andersen, T., Sørensen, H. and Simonsen, T. 2002. Biomechanical Differences in Soccer Kicking With the Preferred and the Non-Preferred Leg. *Journal of Sports Sciences*; 20: 293- 299

Draper, S.W. 2002. *The Hawthorne, Pygmalion, Placebo and Other Effects of Expectation: Some Notes*. [online] Available from: http://www.psy.gla.ac.uk/~steve/hawth.html. [Accessed 20 September 2007].

Esterhuizen, T. (Private communications), 16 August 2010, 14:06 PM

Fox, M. 2006. Effect on Hamstring Flexibility of Hamstring Stretching Compared to Hamstring Stretching and Sacroiliac Joint Manipulation. *Clinical Chiropractic*; 9:21—32.

Franke, R.H. and Kaul, J.D. 1978. The Hawthorne Experiments: First Statistical Interpretation. *American Sociological Review*; *43: 623–643.*

Gatterman, M.I. 1995. *Foundations of Chiropractic.* Mosby-Year Book, inc.

Gatterman, M.I. 2003. *Chiropractic Management of Spine Related Disorders*. Baltimore: Lippincott Williams & Wilkins.

Gatterman, M.I., Cooperstein, R., Lantz, C., Perle, S.M. and Schneider, M.J. 2001. Rating Specific Chiropractic Technique Procedures for Common Low Back Conditions. *Journal of Manipulative and Physiological Therapeutics*; 24(7): 449-456.

Gilchrist, R, Frey, M and Nadler, S. 2003. Muscular Control of the Lumbar Spine. *Pain Physician*; 6:361-368

Gross, A, Miller, J, D'Sylva, J, Burnie J, Goldsmith, C, Graham, N, Haines, T, Brønfort, G and Hoving, J. 2010. Manipulation or Mobilisation For Neck Pain. *Manual Therapy*; 15:315-333.

Herzog, W. 2000. *The Mechanical, Neuromuscular and Physiologic Effects Produced by the Spinal* Manipulation. In Herzog, W. (ed.) *Clinical Biomechanics of Spinal* Manipulation. New York: Churchill Livingstone.

Hilligan, B. 2008. *The Relationship Between Core Stability and Bowling Speed in Asymptomatic Male Indoor Action Cricket Bowlers*. M.Tech:Chiropractic dissertation, Durban University of Technology.

How to Strike the Ball [online]. 2009. Available at: http://www.expertfootball.com/training/kicking.php [Accessed 2 February 2011].

Ingley, B and Harris, B. 2001. *Soccer Kick Biomechanics* [online]. Available at: http://www.ultimatesoccercoaching.com/soccer-kick/soccer-kick-biomechanics.html [Accessed 18 November 2009].

Ishmail, A, Mansor, M, Ali, M, Jaafar, S and Johar, M. 2010. Biomechanics Analysis for Right Leg Instep Kick. *Journal of Applied Sciences*; 10(13): 1286-1292.

Kellis, E and Katis, A. 2007. Biomechanical Characteristics and Determinants of Instep Soccer Kick. *Journal of Sports Science and Medicine*; 6: 154-165.

Kirkaldy-Willis, W.H. and Bernard, T.N. 1999*. Managing Low Back Pain.* 4th ed. NewYork: Churchill Livingstone.

Kruger, H.T. 1999. *The Effect of Spinal* Manipulation *in Chronic Low Back Pain Sufferers in Terms of Clinical and Immune Cellular Responses.* M. Tech. Dissertation, Technikon Natal.

Lederman, E. 2005. *The Science and Practice of Manual Therapy*. Churchill Livingstone: Elsevier Health.

Lees, A. 1996. *Biomechanics Applied to Soccer Skills. In: Science and Soccer*. Ed: Reilly, T. London: E and FN Spon.

Lees, A. and Nolan, L. 1998. The Biomechanics of Soccer: A Review. *Journal of Sports Sciences*; 16: 211-234.

Maigne, J.Y. and Vautravers, P. 2003. Mechanism of Action of Spinal Manipulative Therapy. *Joint Bone Spine*; 70: 336-341.

Mayer, T.G., Kondraske, G., Beals, S.B. and Gatchel, R.J. 1997. Spinal range of motion. Accuracy and sources of error with inclinometric measurement. *Spine;* 22(17):1976-1984.

Mayo, E. 1993. *The Human Problems of an Industrial Civilization.* 2nd ed. New York: MacMillan.

McCarney, R., Warner, J., Iliffe, S., Van Haselen, R., Griffin, M. and Fisher, P. 2007. The Hawthorne Effect: a Randomised, Controlled Trial. *BMC Medical Research Methodology*; 7:30.

McConnell, J.V. and Philipchalk, R.P. 1992. *Understanding Human Behaviour*. 7th ed. New York: Harcourt Brace Jovanovich.

Moore, K.L. and Dalley, A.F. 2005. *Clinically Oriented Anatomy.* 5th ed. Baltimore: Lippincott Williams and Wilkins.

Mouton, J. 1996. *Understanding Social Research.* 3rd ed. Pretoria: Van Shaik Publishers.

Myburgh, C. 1998. *The Relative Effectiveness of Specific Passive Mobilization Versus Spinal* Manipulation *in the Treatment of Mechanical Low Back Pain.* M. Tech. Dissertation, Technikon Natal.

Nunome, H, Georgakis, A, Shinkai, H, Suito, H, Tsujimoto, N and Ikegami, Y. 2007. Impact Phase Kinematics of Side-Foot and Instep Soccer Kick. *Journal of Biomechanics;* 40(S2).

Pickar, J. 2002. Neurophysiological Effects of Spinal Manipulation. *The Spinal Journal*; 2(5):357-371.

Redwood, D. 2003. Spinal Adjustment for Low Back Pain. *Seminars in Integrative Medicine*; 1(1):42-52.

Roethlisberger, F.J. and Dickson, W.J. 1939. *Management and the Worker.* Cambridge, Massachusetts: Harvard University Press.

Saunders, H. 1998. *Saunders Digital Inclinometer Users Guide*. The Saunders Group, Inc.

Schafer, R and Faye, J. 1990. *Motion Palpation and Chiropractic Technique*. 2nd ed. Huntington Beach: The Motion Palpation Institute.

Sood, K. 2008. *The Immediate Effect of Lumbar Spine* Manipulation*, Thoracic Spine* Manipulation*, Combination Lumbar and Thoracic Spine* Manipulation *and*

Sham Laser on Bowling Speed in Action Cricket Fast Bowlers. M.Tech:Chiropractic dissertation, Durban University of Technology.

Sterzing, T and Henning E. 2007. The Influence of Friction Properties of Shoe Upper Materials On Kicking Velocity In Soccer*. Journal of Biomechanics*; 40(2):195.

Steyn, S. *Biomechanics of Soccer: The Soccer-Style Kick - a Slow-Motion Commentary on One of the Most Common Sporting Actions in the World* [online]. 2004. Available at: http://www.sportsinjurybulletin.com/archive/biomechanics-soccer.htm [Accessed 18 November 2009].

Subotnick, S. 1991. *Sports and Exercise Injuries: Conventional, Homeopathic and Alternative Treatments*. California: North Atlantic Books.

Subotnick, S. 1999. 2nd Edition. *Sports Medicine of the Lower Extremity*. California: Churchhill Livingstone.

Suter, E, McMorland, G, Herzog, W, and Bray, R. 2000. Conservative Lower Back Treatment Reduces Inhibition in Knee-Extensor Muscles: A Randomized Controlled Trial. *Journal of Manipulative and Physiological Therapeutics*; 25(2):76-80.

Szaraz, Z.T. 1990. *Compendium of Chiropractic Technique.* 2nd ed. Toronto: Vivian L.R.Associates Ltd. Technical Publications.

Wall, M. and Wheeler, S. 1996. Benefits of the Placebo Effect in the Therapeutic Relationship. *Complementary Therapies in Nursing and Midwifery*; 2: 160-163.

Wilder, D.G., Pope, M.H. and Frymoyer, J.W. 1988. The Biomechanics of Lumbar Disc Herniation and the Effect of Overload and Instability. *Journal of Spinal Disorders*; 1:16-32.

Williams, A., Newell, R.L.M. and Collins, P. 2005. Back and Macroscopic Anatomy of Spinal Cord. In Standring, S. (ed) *Gray's Anatomy*. 39th ed. Edinburgh: Churchill Livingstone.

Young, W, Clothier, P, Otago, L, Bruce, L and Liddell, D. 2004. Acute Effects of Static Stretching on Hip Flexor and Quadriceps Flexibility, Range of Motion and Foot Speed in Kicking a Football. *Journal of Science and Medicine in Sport*; 7(1):23-31.

APPENDIX A- LETTERS OF INFORMATION AND CONSENT

Date:

Dear Participant, welcome to my research project.

Title of Research: The immediate effect of sham laser and three different spinal manipulative protocols on kicking speed in soccer players.
Name of student: Kyle Deutschmann
Name of supervisor: Dr. A. Jones **(M. Dip. C; MMED.Sci (Sports medicine))**
Contact number: (031) 9034467

You have been selected to take part in a study investigating the immediate effect of manipulation on the kicking speed and range of motion of soccer players, currently playing in their regional premier league or higher. Forty subjects will be required to complete this study. Each participant has a 1 in 4 chance of falling into a placebo group.

To be part of this study you must

- Be between the ages of 18-35 years.
- Give informed consent to participate in the research.
- You must be asymptomatic with regards to any lower back pain or any pain experienced while kicking.

You will not be eligible to take part in this study if you

- Have any contraindications to manipulation.
- Are not currently playing for a regional premier league team or higher.

Research procedure

- You will be required to attend a one hour consultation at the D.U.T Chiropractic Clinic followed by a 30 minute consultation at the Highway Action Arena in New Germany.
- You will be required to perform the instructed warm up and kicking procedures and to comply with the range of motion tests.

Benefits to the participant

- You will become aware of how fast you are able to kick the ball.

Reason/s why the subject may be withdrawn from the study

- If you are non-compliant of what is expected of you during the consultation.
- If on motion palpation your range of motion of the treated fixation does not improve.

Confidentiality

All personal details and relevant information gathered through the research process will only be accessible by the researcher (Kyle Deutschmann) and supervisor (Dr. Andrew Jones). Once all the relevant data has been gathered and analyzed, it will be disposed of in a professional manner, not being made available to the general public.

Persons to contact in the event of any problems or queries

Myself: Kyle Deutschmann Contact details: 0837799293
Supervisor: Dr A. Jones (M. Dip. C; MMED.Sci (Sports medicine))
Contact details: Work: (031) 9034467
Faculty of Health, Research coordinator: Mr V. Singh
Contact details: 031-3732701

I…………………………………… (Subjects full name) ………………………… (ID number), have read this document in its entirety and understand its contents. Where I have had any questions or queries, these have been explained to me by Kyle Deutschmann to my satisfaction. Furthermore, I fully understand that I may withdraw from this study without any adverse consequences and my future health care will not be compromised. I, therefore, voluntarily agree to participate in the study.

Subject's name(print)……………………… Signature ……………...Date ………….

Researcher's name…………………………Signature ………………Date ………….

Witness name ………………………………Signature ………………Date ………….

APPENDIX B

Attention all Competitive Soccer players

Are you healthy, between 18 and 35 years of age, and interested in having your kicking speed measured?

Research* is being conducted at the Local Action Cricket Arenas on 4 interventions which may affect kicking speeds.

If you are interested in participating in this study, please contact Kyle on 031-3732205

*This research is being conducted under the auspices of the Durban University of Technology

APPENDIX C- Case History

DURBAN UNIVERSITY OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient:______________________________ Date:__________

File # : __________ Age: __________

Intern:__________________ Signature __________________

FOR CLINICIANS USE ONLY:

Initial visit

Clinician: Signature:

Case History:

Examination:

Previous: Current:

X-Ray Studies:

Previous: Current:

Clinical Path. lab:

Previous: Current:

CASE STATUS:

PTT:	Signature:	Date:

CONDITIONAL: Reason for Conditional:	
Signature:	Date:

Conditions met in Visit No:	Signed into PTT:	Date:
Case Summary signed off:		Date:

Intern’s Case History:

1. **Source of History:**
2. **Chief Complaint: (patient’s own words):**
3. **Present Illness:**

	Complaint 1	**Complaint 2**
Location Onset : Initial: Recent: Cause: Duration Frequency Pain (Character) Progression Aggravating Factors Relieving Factors Associated S & S Previous Occurrences Past Treatment Outcome:		

4. **Other Complaints:**
5. **Past Medical History:**

- General Health Status
- Childhood Illnesses
- Adult Illnesses
- Psychiatric Illnesses
- Accidents/Injuries
- Surgery
- Hospitalizations

6. **Current health status and life-style:**

- Allergies
- Immunizations
- Screening Tests incl. x-rays
- Environmental Hazards (Home, School, Work)
- Exercise and Leisure
- Sleep Patterns
- Diet
- Current Medication

  Analgesics/week:
- Tobacco
- Alcohol
- Social Drugs

7. Immediate Family Medical History:

- Age
- Health
- Cause of Death
- DM
- Heart Disease
- TB
- Stroke
- Kidney Disease
- CA
- Arthritis
- Anaemia
- Headaches
- Thyroid Disease
- Epilepsy
- Mental Illness
- Alcoholism
- Drug Addiction
- Other

8. Psychosocial history:

- Home Situation and daily life
- Important experiences
- Religious Beliefs

9. Review of Systems:

- General
- Skin
- Head
- Eyes
- Ears
- Nose/Sinuses
- Mouth/Throat
- Neck
- Breasts
- Respiratory
- Cardiac
- Gastro-intestinal
- Urinary
- Genital
- Vascular
- Musculoskeletal
- Neurologic
- Haematologic
- Endocrine
- Psychiatric

APPENDIX D- Physical Examination

Durban University of Technology PHYSICAL EXAMINATION: SENIOR
Patient Name : **File no :** **Date :** **Student :** **Signature :**

VITALS:				
Pulse rate:			Respiratory rate:	
Blood pressure:	R	L	Medication if hypertensive:	
Temperature :			Height:	
Weight:	Any recent change? Y / N		If Yes: How much gain/loss	Over what period

GENERAL EXAMINATION:		
General Impression		
Skin		
Jaundice		
Pallor		
Clubbing		
Cyanosis (Central/Peripheral)		
Oedema		
Lymph nodes	Head and neck	
	Axillary	
	Epitrochlear	
	Inguinal	
Pulses		
Urinalysis		

SYSTEM SPECIFIC EXAMINATION:
CARDIOVASCULAR EXAMINATION
RESPIRATORY EXAMINATION
ABDOMINAL EXAMINATION
NEUROLOGICAL EXAMINATION
COMMENTS

Clinician:	**Signature :**

APPENDIX E- Regional Examination of the Lumbar Spine and Pelvis

Patient:_________________________________File#:______Date:_________

Intern\Resident:___________________________________ Clinician:___________________

STANDING:

Posture– scoliosis, antalgia, kyphosis
Body Type
Skin
Scars
Discolouration

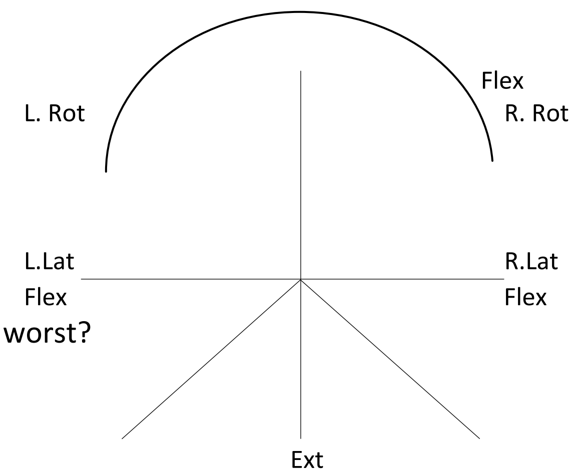
Minor's Sign
Muscle tone
Spinous Percussion
Scober's Test (6cm)
Bony and Soft Tissue Contours

GAIT:

Normal walking
Toe walking
Heel Walking
Half squat

ROM:

Forward Flexion = 40-60° (15 cm from floor)
Extension = 20-35°
L/R Rotation = 3-18°
L/R Lateral Flexion = 15-20°



Which movt. reproduces the pain or is the worst?

- Location of pain
- Supported Adams: Relief? (SI)
- Aggravates? (disc, muscle strain)

SUPINE:

Observe abdomen (hair, skin, nails)
Palpate abdomen\groin
Pulses - abdominal
- lower extremity
Abdominal reflexes

		Degree	LBP?	Location	Leg pain	Buttock	Thigh	Calf	Heel	Foot	Braggard
SLR	L										
	R										

	L	R
Bowstring		
Sciatic notch		
Circumference (thigh and calf)		
Leg length: actual -		
apparent -		
Patrick FABERE: pos\neg – location of pain?		
Gaenslen's Test		
Gluteus max stretch		

Piriformis test (hypertonicity?)		
Thomas test: hip \ psoas? \ rectus femoris?		
Psoas Test		

SITTING:

Spinous Percussion
Valsalva
Lhermitte

TRIPOD Sl, +, ++		Degree	LBP?	Location	Leg pain	Buttock	Thigh	Calf	Heel	Foot	Braggard
	L										
	R										

Slump 7 test	L										
	R										

LATERAL RECUMBENT:

	L	R
Ober's		
Femoral n. stretch		
SI Compression		

PRONE:

	L	R
Gluteal skyline		
Skin rolling		
Iliac crest compression		
Facet joint challenge		
SI tenderness		
SI compression		
Erichson's		
Pheasant's		

MF tp's	Latent	Active	Radiation
QL			
Paraspinal			
Glut Max			
Glut Med			
Glut Min			
Piriformis			
Hamstring			
TFL			
Iliopsoas			
Rectus Abdominis			
Ext/Int Oblique muscles			

NON ORGANIC SIGNS:

Pin point pain
Axial compression
Trunk rotation
Burn's Bench test

Flip Test
Hoover's test

Ankle dorsiflexion test
Repeat Pin point test

NEUROLOGICAL EXAMINATION

Fasciculations
Plantar reflex

level	Tender?	Dermatomes		DTR		
		L	R		L	R
T12				Patellar		
L1				Achilles		
L2						
L3				Proproception		
L4						
L5						
S1						
S2						
S3						

MYOTOMES

Action	Muscles	Levels	L	R	
Lateral Flexion spine	Muscle QL				
Hip flexion	Psoas, Rectus femoris				5+ Full strength
Hip extension	Hamstring, glutes				4+ Weakness
Hip internal rotation	Glutmed, min;TFL, adductors				3+ Weak against grav
Hip external rotation	Gluteus max, Piriformis				2+ Weak w\o gravity
Hip abduction	TFL, Glut med and minimus				1+ Fascic w\o gross movt
Hip adduction	Adductors				0 No movement
Knee flexion	Hamstring,				
Knee extension	Quad				W – wasting
Ankle plantarflex	Gastroc, soleus				
Ankle dorsiflexion	Tibialis anterior				
Inversion	Tibialis anterior				
Eversion	Peroneus longus				
Great toe extension	EHL				

BASIC THORACIC EXAM

History

Passive ROM

Orthopedic

MOTION PALPATION AND JOINT PLAY

L R

BASIC HIP EXAM

History

ROM: Active

Passive : Medial rotation : A) Supine (neutral) If reduced
- hard \ soft end feel

B) Supine (hip flexed):

Trochanteric bursa

APPENDIX F- Soape

Patient Name: **File #:** **Page:**

Date: **Visit:** **Intern:**
Attending Clinician: **Signature:**

S: **Numerical Pain Rating Scale** **(Patient)** **Intern Rating** **A:**
Least 0 1 2 3 4 5 6 7 8 9 10 Worst ☐

0: **P:**

E:

Special attention to: **Next appointment:**

Date: **Visit:** **Intern:**
Attending Clinician: **Signature:**

S: **Numerical Pain Rating Scale (Patient)** **Intern Rating** **A:**
Least 0 1 2 3 4 5 6 7 8 9 10 Worst ☐

0: **P:**

E:

Special attention to: **Next appointment:**

Date: **Visit:** **Intern:**
Attending Clinician: **Signature:**

S: **Numerical Pain Rating Scale (Patient)** **Intern Rating** **A:**
Least 0 1 2 3 4 5 6 7 8 9 10 Worst ☐

O: **P:**

E:

Special attention to: **Next appointment:**

Clinician: **Signature :**

APPENDIX G- Subjects' Perception of Change in Kicking Speed

Group1	Sub.	Increased	Decreased	No change	Group2	Sub.	Increased	decreased	No change
	1					1			
	2					2			
	3					3			
	4					4			
	5					5			
	6					6			
	7					7			
	8					8			
	9					9			
	10					10			

Group3	Sub.	Increased	Decreased	No change	Group4	Sub.	Increased	decreased	No change
	1					1			
	2					2			
	3					3			
	4					4			
	5					5			
	6					6			
	7					7			
	8					8			
	9					9			
	10					10			

Appendix H- Warm-up Routine

Each subject will be put through a set of stretches for seven minutes prior to kicking. The subjects will be shown how to perform these stretches by the researcher, according to the methods described by Travell and Simons (1993a and 1993b).

- A warm up run around the outside of the indoor court (2 minutes).

- A seated self-stretch for the hamstrings (2x 30 seconds). Performed by slowly and gently sliding the fingers down the shins, keeping the knees straight. Post isometric relaxation combined with deep breathing enhanced relaxation in the hamstrings.

- A prone self-stretch for the quadriceps (30 seconds each side). The subject lies on the opposite side to the side being stretched, and uses their hand to hold the ankle and slowly bring the heel against the buttock to flex the knee fully while maintaining and then increasing extension of the thigh at the hip by also pulling the knee and thigh posteriorly.

- A seated stretch for the adductor muscles (2x 30 seconds). The legs are bent at the knees and the soles of the feet brought together. The subject then pushes down on the knees with their elbows to cause an increased stretch on the adductor muscles.

- A supine self-stretch for the quadratus lumborum (30 seconds each side). The starting position for this stretch is supine, with the hips and knees bent. The hands are placed behind the head to elevate the rib cage. The controlling left leg is crossed over the right thigh (the side to be stretched). After the right thigh is adducted as far as possible without resistance, during slow deep inhalation, the left leg is used to resist a gentle isometric abductive effort of the right thigh. The subject then slowly exhaled and relaxed the right side. The same procedure is then performed to stretch the left side.

- A standing stretch for the gastrocnemius and soleus muscles (30 seconds each side). The subject leans forward into a stride stance and places his outstretched hands against the wall. One leg at a time the heel of the back leg is slowly pushed towards the floor.

Appendix I- Statistician Agreement

The Research Committee

Durban University of Technology

Durban

18 August 2010

Re: Kyle Deutschmann research

This is to confirm that I have been consulted by the above mentioned student of the Chiropractic department. I am satisfied with the proposed analysis and have agreed to analyse the data from this research project.

Yours sincerely

[redacted]

TM Esterhuizen

Biostatistician

APPENDIX J- Highway Action Arena, Agreement Letter

29 SHEPSTONE ROAD
New Germany
3610
Tel: +27 31 705 6046
Fax no: +27 31 705 6048
Email: karyn@highwayactionsports.co.za
19 August 2010

To Whom it may concern.

Kyle Deutschmann has approached us with the intent of using the indoor facilities at our sports arena for the purpose of his research into " Kicking speed in soccer players" for his thesis.

We have no objection to him using the facilities and look forward to his feedback on his findings.

We are offering him the use of the courts at no charge.

Yours in sports

[redacted]

Karyn Lawrence

HIGHWAY ACTION SPORTS ARENA

APPENDIX K- Letter from Dr. K .Sood

DR KANWAL SOOD

Chiropractor

(M.Tech: Chiropractic)

Pr. No.: 295019 Reg No.: A10535

RANDLES ROAD MEDICAL CENTRE

468 Randles Road
Sydenham
Durban 4091

Email: kanwalsood@yahoo.co.in

Rooms : 031 207 5252
Fax : 031 207 1567
Cell : 083 556 7949

I have agreed to be Kyle Deutschmann's off-campus supervisor for his research study. I have spoken to his supervisor Dr. Jones and I understand what is needed from me and what the outcomes of the research are. Kyle approached me as I did a similar study with Action cricket fast bowlers.

Kind Regards,

[redacted]

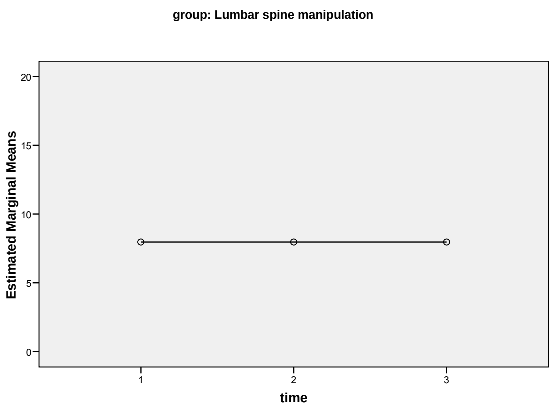
Dr. K.D. Sood (M.TECH: CHIRO)

Appendix L- Sacroiliac Results for Group 1

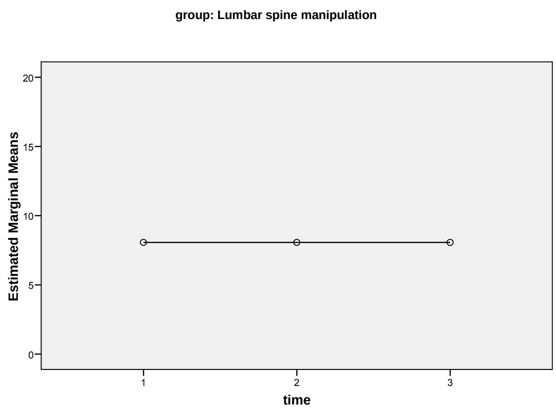
Movement	Effect	Statistic	*p value*
Left SI flexion 1	Time	Wilk's lambda=.	0
Left SI flexion 2	Time	Wilk's lambda=.	0
Right SI flexion 1	Time	Wilk's lambda=.	0
Right SI flexion 2	Time	Wilk's lambda=.	0

There was no effect of this intervention for all SI flexion ROM measurements.

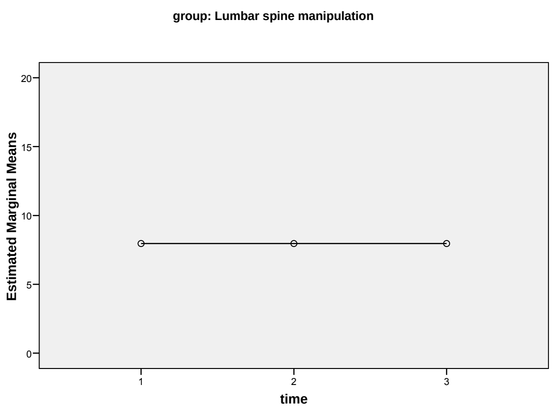
Left Sacroiliac 1



Left Sacroiliac 2



Right Sacroiliac 1



Right Sacroiliac 2

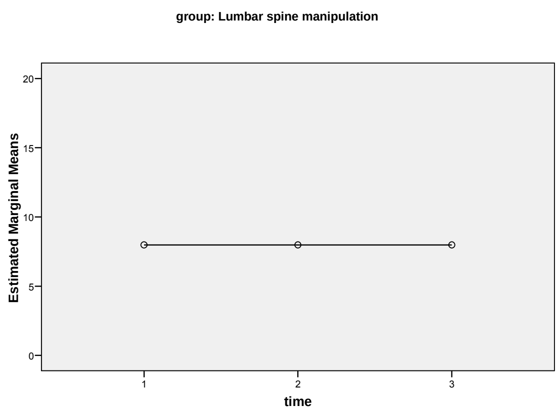


Figure 4.8 Results of ROM Changes in Group 4

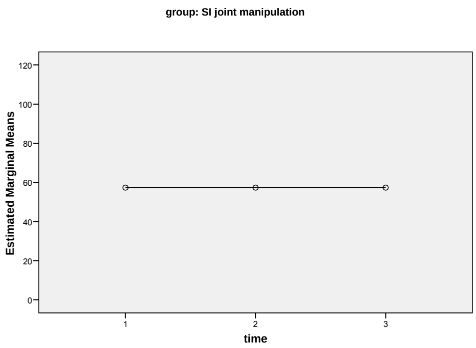
APPENDIX M- Lumbar ROM results from group 2

Table: Range on Motion

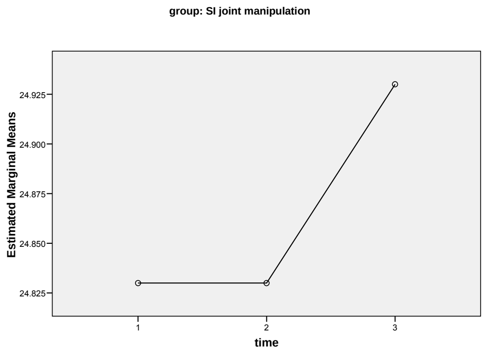
Movement	Effect	Statistic	*p value*
Flexion	Time	Wilk's lambda = .	0
Extension	Time	Wilk's lambda = 0.900	0.343
Left lateral flexion	Time	Wilk's lambda = .	0
Right lateral flexion	Time	Wilk's lambda = .	0
Left rotation	Time	Wilk's lambda = 0.853	0.224
Right rotation	Time	Wilk's lambda = 0.900	0.343

There was no effect of this intervention on any of the lumbar spine ROM measurements.

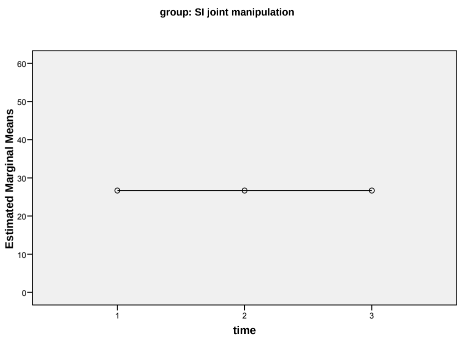
Flexion



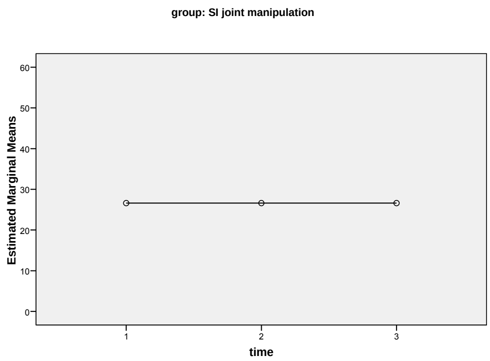
Extension



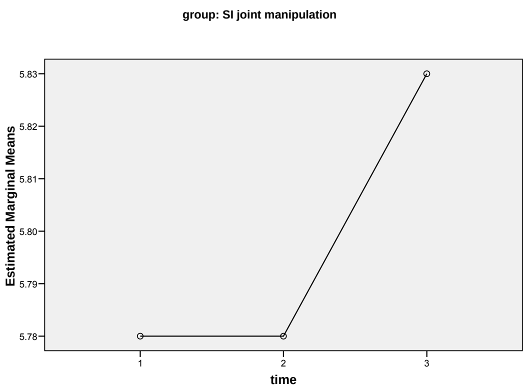
Left Lateral Flexion



Right Lateral Flexion



Left Rotation



Right Rotation

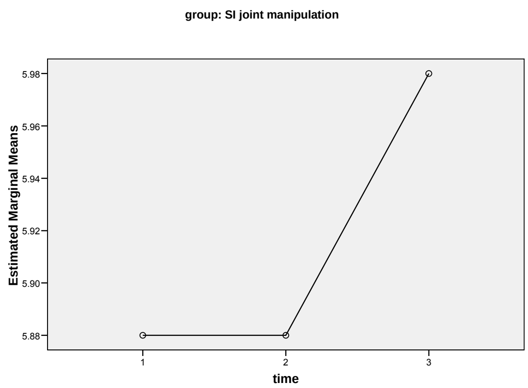


Figure Showing Lumbar Spine ROM changes in Group 2

Appendix N- Ethics Clearance Certificate

ETHICS CLEARANCE CERTIFICATE

Student Name	Kyle Deutschmann	Student No	20429912
Ethics Reference Number	034/10	Date of FRC Approval	20/09/2010
Qualification	Mtech Chiropractic		
Research Title:	The immediate effect of sham laser and three different SMT protocols on kicking speed in soccer players.		

In terms of the ethical considerations for the conduct of research in the Faculty of Health Sciences, Durban University of Technology, this proposal meets with Institutional requirements and confirms the following ethical obligations:

1. The researcher has read and understood the research ethics policy and procedures as endorsed by the Durban University of Technology, has sufficiently answered all questions pertaining to ethics in the DUT 186 and agrees to comply with them.
2. The researcher will report any serious adverse events pertaining to the research to the Faculty of Health Sciences Research Ethics Committee.
3. The researcher will submit any major additions or changes to the research proposal after approval has been granted to the Faculty of Health Sciences Research Committee for consideration.
4. The researcher, with the supervisor and co-researchers will take full responsibility in ensuring that the protocol is adhered to.
5. ***The following section must be completed if the research involves human participants:***

	YES	NO	N/A
❖ Provision has been made to obtain informed consent of the participants	X		
❖ Potential psychological and physical risks have been considered and minimised	X		
❖ Provision has been made to avoid undue intrusion with regard to participants and community	X		
❖ Rights of participants will be safe-guarded in relation to: - Measures for the protection of anonymity and the maintenance of Confidentiality.	X		
- Access to research information and findings.	X		
- Termination of involvement without compromise	X		
- Misleading promises regarding benefits of the research	X		

[redacted]

Appendix O- Data readings

Graph Showing Kicking Speeds Pre and Post intervention in km/h

		Kicking speed pre intervention		Kicking speed post intervention	
Group	Subject	avg.	max.	avg.	max.
1	1	79	81	79.7	83
	2	71	76	73	75
	3	100.7	103	98.3	103
	4	83.3	88	92.3	100
	5	95	97	98	99
	6	93	101	96	102
	7	106	111	108	110
	8	109.7	110	115.3	117
	9	102	103	106.3	109
	10	97	102	105	111
Group2	1	79	80	80.3	84
	2	103.3	106	104	108
	3	94.7	98	104	113
	4	92	94	97.7	101
	5	75	79	82.3	85
	6	98.3	101	103	107
	7	82	88	94.3	101
	8	97.3	99	100.3	102
	9	105	108	109	110
	10	115.3	117	121.3	124
Group 3	1	101.3	104	106.7	108
	2	92	94	98.7	100
	3	103.3	107	105.3	110
	4	85.3	99	94.7	100
	5	92	97	98	100
	6	107.7	113	117.7	122
	7	102	104	107.3	108
	8	95.3	104	101.3	105
	9	91.7	95	104	107
	10	89.7	93	92.3	96
Group 4	1	107.3	111	107	109
	2	100	104	94.7	95
	3	101.3	104	101	105
	4	90.3	91	90	90
	5	90.3	94	84.7	86
	6	104	105	104	106
	7	89	93	89	92
	8	107.3	109	107.7	110
	9	108	110	106	108
	10	102.7	104	101.7	103

Graph Showing the Range of Motion Measurements Pre Warm-up in Degrees

Pre warm-up	Lumbar spine	flex	ext	L lat flex	R lat flex	l rot	r rot	L SI flex1	L SI flex2	R SI flex1	R SI flex 2
group	Subject										
Group 1	1	54	23.5	21	20.8	5.2	4.8	6.4	6.6	6.8	6.8
	2	58	24	23	25	5	5	7.2	7	7.2	7
	3	60	25	26	26	4.8	4.7	8.2	8.6	7.8	7.8
	4	55	22	20.4	23	4.8	4.2	8.6	8.6	9.2	9.2
	5	55	24.3	28.4	28.4	5.2	5.6	8.6	8.5	8.7	8.6
	6	53	22	23	23.3	3.9	4	5.6	6	6.2	6.4
	7	50	25	28	28	5.8	5.8	8.3	8.6	7.9	8.2
	8	64	26	28.3	28	4.8	5.5	7.8	7.6	7.6	7.4
	9	59	25.3	26	26	5	4.6	10.3	10.3	9.8	9.8
	10	59.3	25.3	26	26	5	4.6	8.7	8.9	8.4	8.6
Group 2	1	55.6	24.8	28.2	28.4	5.6	5.6	7.2	7.5	7.4	7.5
	2	57	23	23.5	23.2	5.2	5.3	8.4	8.4	8	8.2
	3	55.8	24.5	29	28.7	5.6	6	8.6	8.5	8.7	8.6
	4	54	22	24	24	4.2	4.6	7.1	7	7	7.2
	5	50	27	28	28	6	6.1	8.4	8.6	8	8.2
	6	64	26	28.3	28.2	5.9	5.6	7	7	8.5	8.5
	7	60	25.2	26	26.2	5	5	6.2	6.1	5.6	5.8
	8	57	23	23.5	23.2	5.2	5.3	8.2	8	8.4	8.4
	9	56	26.8	27	28.7	6.2	6.4	9.6	9.8	9.2	9.5
	10	64	26	28.6	28.3	8.9	8.9	6.2	6.4	8.4	8.3
Group 3	1	55	26.3	23.2	23	5.1	5	8.8	8.7	8.2	8.7
	2	54.6	24.8	25	25	4.2	4.6	7.5	7.8	8	8.2
	3	50	25	28	28	5.8	5.8	8.8	8.9	8.6	8.6
	4	64	26	28.3	28	4.8	5.5	7.4	7.5	5.6	5.8
	5	59	25.3	26	26	5	4.6	7.2	7.2	8.6	8.6
	6	59.3	25.3	26	26	5	4.6	7.4	7.2	6.2	6.7
	7	60	25	26	26	4.8	4.7	6.8	6.8	5.8	6.1
	8	55	22	20.4	23	4.8	4.2	7.1	7	7.8	7.6
	9	55	24.3	28.4	28.4	5.2	5.6	8	9.1	6.7	7
	10	53	22	24.8	25.6	4.2	4.9	5.6	6	6.3	7
Group 4	1	64	26	28.3	28	4.8	5.5	7.4	7.5	7.2	7
	2	59	25.3	26	26	5	4.6	7.2	7.2	7.2	7
	3	55.8	24.5	29	28.7	5.6	6	8.6	8.5	9.2	9.2
	4	54	22	24	24	4.2	4.6	8.5	8.3	8.7	8.6
	5	57	23	23.5	23.2	5.2	5.3	8.2	8	7.6	8
	6	56	26.8	27	28.7	6.2	6.4	7	7.4	6.8	6.6
	7	60	25.2	26	26.2	5	5	8.2	8.6	8	8.5
	8	57	23	23.5	23.2	5.2	5.3	8.6	8.6	8.2	8
	9	64	26	28.3	28.2	6	5.6	7.7	7.5	7.8	7.7
	10	60	25.2	26	26.2	5.4	6	6.2	6.1	6	6.3

Graph Showing the Range of Motion Measurements Post Warm-up in Degrees

Post warm-up	Lumbar spine	flex	ext	L lat flex	R lat flex	l rot	r rot	L SI flex1	L SI flex2	R SI flex1	R SI flex 2
group	Subject										
Group 1	1	54	23.7	22	21	5.2	4.8	6.4	6.6	6.8	6.8
	2	58	24	23	25	5	5	7.2	7	7.2	7
	3	60	25.2	26	26.2	4.8	4.9	8.2	8.6	7.8	7.8
	4	56	23	20.4	23	5	4.2	8.6	8.6	9.2	9.2
	5	55	24.3	28.4	28.4	5.2	5.6	8.6	8.5	8.7	8.6
	6	53	22	23	23.4	3.9	4	5.6	6	6.2	6.4
	7	50	25	28	28	5.8	5.8	8.3	8.6	7.9	8.2
	8	64	26	28.3	28.2	4.9	5.5	7.8	7.6	7.6	7.4
	9	59	25.3	26	26	5	4.6	10.3	10.3	9.8	9.8
	10	59.3	25.3	26	26	5	4.6	8.7	8.9	8.4	8.6
Group 2	1	55.6	24.8	28.2	28.4	5.6	5.6	7.2	7.5	7.4	7.5
	2	57	23	23.5	23.2	5.2	5.3	8.4	8.4	8	8.3
	3	55.8	24.5	29	28.7	5.6	6	8.6	8.5	8.7	8.6
	4	54	22	24	24	4.2	4.6	7.2	7	7	7.2
	5	50	27	28	28	6	6.1	8.4	8.6	8	8.3
	6	64	26	28.3	28.2	5.9	5.6	7.2	7	8.5	8.5
	7	60	25.2	26	26.2	5	5	6.2	6.1	5.6	5.8
	8	57	23	23.5	23.2	5.2	5.3	8.2	8	8.4	8.4
	9	56	26.8	27	28.7	6.2	6.4	9.6	9.8	9.3	9.5
	10	64	26	28.6	28.3	8.9	8.9	6.2	6.4	8.4	8.3
Group 3	1	55	26.3	23.2	23	5.1	5	8.8	8.7	8.3	8.7
	2	55	24.8	25	25	4.2	4.6	7.6	7.8	8	8.2
	3	50	25	28	28	5.8	5.8	8.8	8.9	8.6	8.6
	4	64	26	28.3	28.2	4.9	5.5	7.4	7.5	5.8	5.8
	5	59	25.3	26	26	5	4.6	7.2	7.2	8.6	8.6
	6	59.3	25.3	26	26	5	4.6	7.4	7.2	6.2	6.7
	7	60	25.2	26	26.2	4.8	4.9	6.8	6.8	5.8	6.1
	8	56	23	20.4	23	5	4.2	7.1	7	7.8	7.6
	9	55	24.3	28.4	28.4	5.2	5.6	8	9.1	6.7	7
	10	53	22	24.8	25.6	4.2	4.9	5.6	6	6.3	7
Group 4	1	64	26	28.3	28	4.8	5.5	7.4	7.5	7.2	7
	2	59	25.3	26	26	5	4.6	7.2	7.2	7.2	7
	3	55.8	24.5	29	28.7	5.6	6	8.6	8.5	9.2	9.2
	4	54	22	24	24	5.3	5	8.5	8.3	8.7	8.6
	5	57	23	23.5	23.2	5.2	5.3	8.2	8	7.6	8
	6	56	26.8	27	28.7	6.2	6.4	7	7.4	6.8	6.6
	7	60	25.2	26	26.2	5	5	8.2	8.6	8	8.5
	8	57	23	23.5	23.2	5.2	5.3	8.6	8.6	8.2	8
	9	64	26	28.3	28.2	6	5.6	7.7	7.5	7.8	7.7
	10	60	25.2	26	26.2	5.4	6	6.2	6.1	6	6.3

Graph Showing the Range of Motion Measurements Post Intervention in Degrees

Post intervention	Lumbar spine	flex	ext	L lat flex	R lat flex	l rot	r rot	L SI flex1	L SI flex2	R SI flex1	R SI flex 2
group	Subject										
Group 1	1	54	24	22	22	5.2	5.4	6.4	6.6	6.8	6.8
	2	58	25	25	25	5	5	7.2	7	7.2	7
	3	60	25.2	26	26.2	5	5	8.2	8.6	7.8	7.8
	4	57	23	23.5	23.2	5.2	5.3	8.6	8.6	9.2	9.2
	5	55.8	24.5	29	28.7	5.6	6	8.6	8.5	8.7	8.6
	6	54	22	24	24	4.2	4.6	5.6	6	6.2	6.4
	7	50	27	28	28	6	6.1	8.3	8.6	7.9	8.2
	8	64	26	28.3	28.2	5.9	5.6	7.8	7.6	7.6	7.4
	9	59	25.3	26	26	5.6	5.2	10.3	10.3	9.8	9.8
	10	59.6	25.3	26	26	5.6	5.2	8.7	8.9	8.4	8.6
Group 2	1	55.6	24.8	28.2	28.4	5.6	5.6	7.3	7.7	7.3	7.7
	2	57	23	23.5	23.2	5.2	5.3	8.4	8.4	8.6	8.6
	3	55.8	24.5	29	28.7	5.6	6	8.9	9	9.2	9
	4	54	22	24	24	4.2	4.6	8	7.8	7	7.2
	5	50	27	28	28	6	6.1	8.4	8.6	8.6	8.6
	6	64	26	28.3	28.2	6	5.6	7.7	7.5	8.5	8.5
	7	60	25.2	26	26.2	5.4	6	6.2	6.1	8.7	8.6
	8	57	24	23.5	23.2	5.2	5.3	8.2	8	8.4	8.4
	9	56	26.8	27	28.7	6.2	6.4	9.6	9.8	9.8	9.8
	10	64	26	28.6	28.3	8.9	8.9	8.6	8.8	8.4	8.3
Group 3	1	55	27	23.2	23	6	6.4	8.8	8.7	9	9.8
	2	55	25.8	26	26	5	4.8	8.2	8.6	8	8.2
	3	50	27	28	28	6	6.1	8.8	8.9	9.2	9
	4	64	26	28.3	28.2	5.9	5.6	7.4	7.5	7.4	7.8
	5	59	25.3	26	26	5.6	5.2	8.1	8.4	8.6	8.6
	6	59.6	28	26	26	6.2	6	7.4	7.2	7.6	8
	7	60	25.2	26	26.2	5	5	6.8	6.8	6.4	6.3
	8	57	23	23.5	23.2	5.2	5.3	8.2	8	7.8	7.6
	9	56	26.8	29	28.7	6	6.4	8	9.1	8.4	8.6
	10	54	24	25.3	25.8	5	5.4	6.2	6.4	6.3	7
Group 4	1	64	26	28.3	28	4.8	5.5	7.4	7.5	7.2	7
	2	59	25.3	26	26	5	4.6	7.2	7.2	7.2	7
	3	55.8	24.5	29	28.7	5.6	6	8.6	8.5	9.2	9.2
	4	54	22	24	24	5.3	5	8.5	8.3	8.7	8.6
	5	57	23	23.5	23.2	5.2	5.3	8.2	8	7.6	8
	6	56	26.8	27	28.7	7	6.8	6.8	6.6	6.4	6.3
	7	60	25.2	26	26.2	5.4	5.2	8.2	8.6	8	8.5
	8	57	23	23.5	23.2	5.2	5.3	8.6	8.6	8.2	8
	9	64	26	28.3	28.2	6	5.6	7.7	7.5	7.8	7.7
	10	60	25.2	26	26.2	5.4	6.4	6.2	6.1	6	6.3