THE USE OF CYBEX II DYNAMOMETER AS AN ADJUNCT IN THE PREVENTION AND MANAGEMENT OF ANKLE SPRAINS

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JOURNAL ARTICLES/CONGRESSES

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2. "The use of the Cybex II as an adjunct in the management of ankle sprains" - Paper presented at the 1991 International Sports Injury Congress, Jerusalem, Israel.

3. "The use of the Cybex II as an adjuct in the prevention of ankle spains" - Paper presented at the 1993 International Sports Injury Congress, Jerusalem, Israel.

ABSTRACT

The management and prevention of ankle sprains has been a topic of controversy in the sport medical literature to date, with various rehabilitative and preventative protocols having been suggested. In part one of this study, a relatively new rehabilitative device, the Cybex II Dynamometer, was used to determine whether the rehabilitation period of ankle sprain injuries could be reduced in recently injured patients. In part two, the Cybex II Dynamometer was used in conjunction with other training techniques in a preventative trial of first league volleyball players, to see whether the incidence of ankle sprains (which is particularly high in this population group) could be reduced.

Although the experimental group was discharged almost 35 percent sooner than the control group in part one, the difference was not found to be statistically significant. In part two, the preventative measures resulted in a notable difference in the incidence of injuries (32 percent in the control group compared to 11 percent in the experimental group). Differences were just not statistically significant ($p=0.059$).

DECLARATION

I declare that this dissertation is my own, except to the extent indicated in the acknowledgements and reference sections. It is being submitted for the degree of Master of Science in Medicine in the University of Witwatersrand, Johannesburg. It has not been submitted before, for any degree of examination in any other University.

ANTHONY HOWARD KALT

18th day of July 1993

I certify that the studies contained in this dissertation have the approval of the Committee for Research on Human subjects. The clearance certificate (number 5/6/87) appears on page V.

---------------------- 18/7/93

SIGNATURE OF APPLICANT DATE

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SIGNATURE OF SUPERVISOR DATE

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PROJECT : The use of the Cybex II Dynamometer as an adjunct in the management and prevention of lateral ankle sprains

INVESTIGATOR/S : A H Kaplan

DEPARTMENT : Physiology

DATE CONSIDERED 26 June 1987

RECOMMENDATION OF COMMITTEE :

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Date : 87/08/04 CHAIRMAN : Murray Lewis

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I/we fully understand the conditions under which I am/we are authorised to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions.

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Dedicated to my wife Lesley for her patience and encouragement.

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LIST OF ABBREVIATIONS/GLOSSARY

"ADS"	Anterior Drawer Sign
"ANOVA"	One-way Analysis of Variance
"ATFL"	Anterior Talofibular Ligament
"CFL"	Calcaneo - Fibular Ligament
"F"	Fisher's Exact Test
"KW"	Kruskal-Wallis Test
"MVT"	Movement
"MW"	Mann-Whitney Test
"P"	Pearson's Chi-Square Test
"PTFL"	Posterior Talofibular Ligament
"T"	Student's T-Test
"UBXT"	Upper Body Exercise Table
"Y"	Yates Corrected Chi-Square Test

Dorsiflexion	Movement of the foot in a sagittal plane in an upward direction (extension).
Extrinsic	Due to a force applied externally.
Intrinsic	Due to a force within the body.
Isokinetic	Movement at a constant speed through a range of motion.
Plantarflexion	Movement of the foot in a sagittal plane in a downward direction (flexion).

Proprioception	Sense of position and appreciation of parts of the body in space.
Sprain	Disruption in the integrity of ligaments
Sydesmosis	A union by ligamentous material of adjacent bones.

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ACKNOWLEDGEMENTS

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PROF G ROGERS: Lecturer, Department of Physiology, University of the Witwatersrand; for his patience, care, advice and encouragement at all times.

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Finally, my sincerest gratitude must go to all the volleyball players and coaches, as well as all the other participants, who took part in this study.

CHAPTER 1 INTRODUCTION

1.1 STATEMENT AND ANALYSIS OF THE PROBLEM.

Injuries are regarded as inevitable in sport, particularly in those sports where body contact is permitted. However, in many cases they are preventable. Prevention of injury is of prime importance. Injuries, and particularly recurrent injuries, are important, not only because they may terminate a sportsman's career, but also because they may affect his whole life (Travers, 1980).

Ankle injuries are probably the most ubiquitous of sports injuries, swimming being one of the only sports with a minimal incidence of ankle sprains. One in seventeen athletes will injure an ankle during his/her athletic season, and 85 percent of these injuries, will be sprains. A sprain may be defined as a "disruption in the congruity of ligaments".

In sports involving quick pivoting on a fixed foot, a high proportion of injuries will involve the ankle (Quigley, 1959). Moehlum and Daljard (1984) found that of the 4673 patients treated for sports injuries in an Oslo Hospital emergency room, 16 percent had sustained an ankle sprain.

A similar incidence has been observed amongst South African sportspersons. Of the 761 injuries treated at the University of Cape Town Sports Injuries Clinic in 1985, 122 or 16 percent were ankle sprains (Kaplan, 1986). The sequelae of ruptures in the ligamentous structures of the ankle joint include chronic instability and post-traumatic osteo-arthritis (Rasmussen 1983a).

In addition ankle sprain injuries are the second greatest contributor to the number of days lost from work because of injury (Choi, 1975). Soboraff et al (1984) estimated that the evaluation and treatment of ankle injuries may amount to annual aggregate dollar charges of approximately two billion dollars, an amount comparable with that spent for coronary artery bypass graft surgery in the United States.

The extensiveness of this problem has become a major concern to the professionals who are responsible for treating these patients, and ensuring their safe ,quick return to normal activity (Hughes and Stetts, 1983).

The literature related to ankle sprain injuries deals mainly with the conflict that exists between conservative treatment and surgery (Blyth 1974, Castaign 1977, Elmslie 1934, Garrick 1977).

Controversy also exists amongst the protagonists of the former, some favouring plaster immobilization (that is immediate immobilization of the injured limb in a plaster cast) and others early mobilization (no cast) (Saunders 1980, Frost 1974, Glick et al 1976, Spring 1967). Guise (1986) focused on the necessity to adequately immobilize the ankle in order to allow for the most rapid healing, and at the same time to rehabilitate the leg as early as possible to establish proprioceptor and adequate muscular control. As yet , however, there has been no uniform, universally accepted protocol for the management of ankle sprains. A treatment modality being used more and more often in the rehabilitation of a variety of sports injuries, is Isokinetic Exercise (Elliot, 1978).

The aims of this study will be to: (i) establish a protocol for the management of ankle sprains, incorporating the use of Isokinetic Exercise; (ii) investigate the use of a preventative programme in the prophylaxis of ankle sprains in a sport associated with extensive lateral movement (eg. volleyball).

CHAPTER 2 THE CYBEX II DYNAMOMETER*

The Isokinetic concept of exercise was first introduced as a means of improving the quality of rehabilitation by James J. Perrine, a consultant engineer, in 1967. Since then it has become one of the most popular methods of resistive exercise and muscle evaluation (Moffroid et al, 1969). Today, it not only plays an integral role in the functioning of most professional football clubs and sports medicine clinics, but has proved to play an important role in occupational injury evaluation, athletics screening and rehabilitation, and verification of treatment results (Elliot, 1978).

The exercise apparatus used in this study which employs concepts of resistance and muscle loading, consists of a lever arm which can be attached to a part of the body and carried through a range of motions.

From its resting position, the lever arm first moves freely for a few degrees without resistance until it attains an operating speed pre-set by a motor driven mechanism inside the unit.

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*Cybex II, Lumex Inc, 100 Spence St, Bayshore, NY 11706.

Once in motion, the lever arm is mechanically prevented from surpassing this speed by the internal mechanism. However, it may be stopped at any point or reversed in motion with the same sequence of action occurring on the reverse movements.

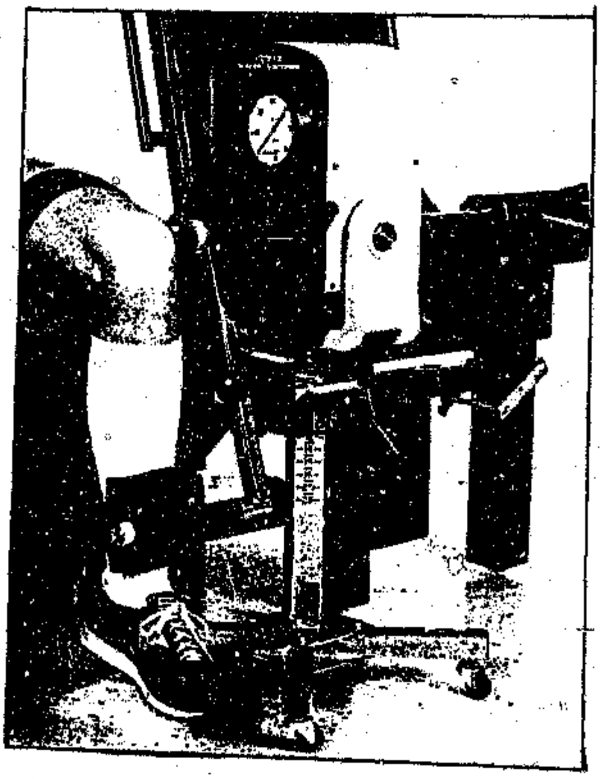

Fig 1 : The Cybex II Isokinetic Dynamometer.

(From Limiting Isolated - Joint Range of Motion, Cybex Division of Lumex Inc, p.1, 1985)

Simply stated, the resistance offered by the machine, matches the patient's immediate and specific muscular capacity. This facility of the apparatus to assure optimum exercise under maximum muscular tension at a constant speed accounts for the term, which has been used for this type of exercise - ie. ACCOMMODATION RESISTANCE.

By allowing the exercise motion to stop and start in any position, the mechanism is able to accommodate to a patient's limited range of motion and yet get maximal resistance within that range. Furthermore, the return movement will not require eccentric contraction of the prime-mover muscle. If desired, the antagonist can be contracted maximally for this return movement.

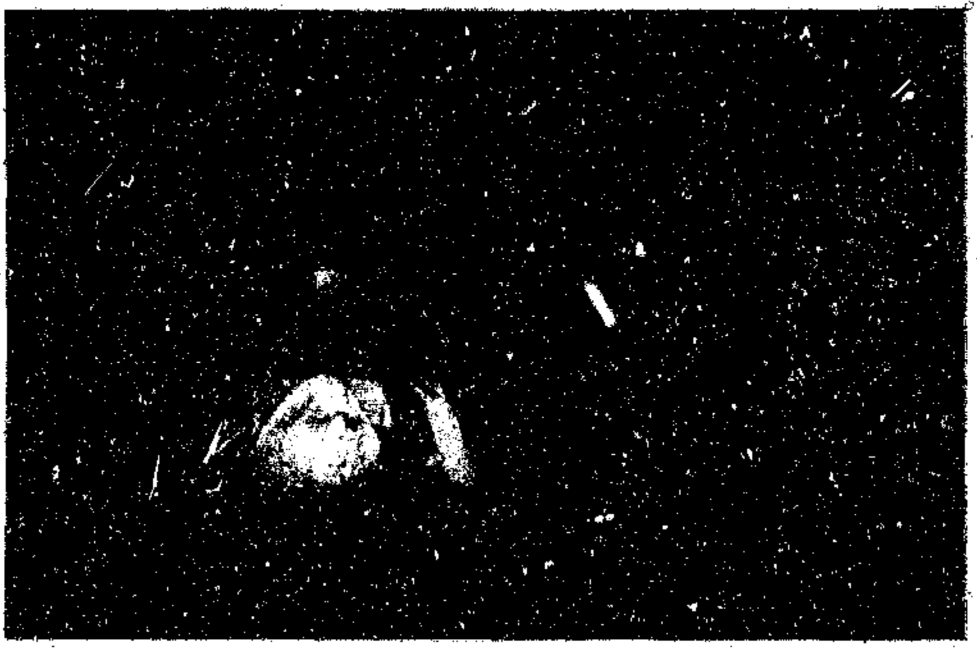

Fig 2-5 : The Cybex II being used in rehabilitation of the ankle.

2.1. USES AS A DYNAMOMETER

The isokinetic apparatus, in addition to its use as an exercise device, can be used in measurement of muscle performance with great accuracy. This is achieved via the instantaneous analysis and graphical printout that can be obtained from the Cybex data reduction computer (fig. 6). It is an instrument which can be adopted for the dynamic study of both normal and abnormal movement patterns, including measurement of such parameters as torque, total work and power rates. "Torque" is a force which acts about an axis of rotation. It is the product of this force times its perpendicular distance from the axis of rotation. "Work" is defined as the action of a force over a specific distance in space. In biomechanics, it refers to the product of muscular force exerted through specific ranges of movement. "Power" refers to the rate of doing work. Applied to muscular performance, it is the work output of muscles at specific speed of contraction. The mechanism of the isokinetic device functions inherently as a versatile dynamometer. The torque that is developed is indicated on the dial. Since exercises which involve lifting of weights are difficult to interpret and standardise, it would appear that measurement of torque is the best index of muscular contraction. A pen recorder attached to the exercise device provides a continuous bracing of the torque curve over a full range of movement.

From this objective record, comprehensive information can be extracted, such as the distribution of force at specific points in the arc, total work performed or power developed. This is obviously compared to the opposite limb for analysis, which is assumed to provide some sort of standard.

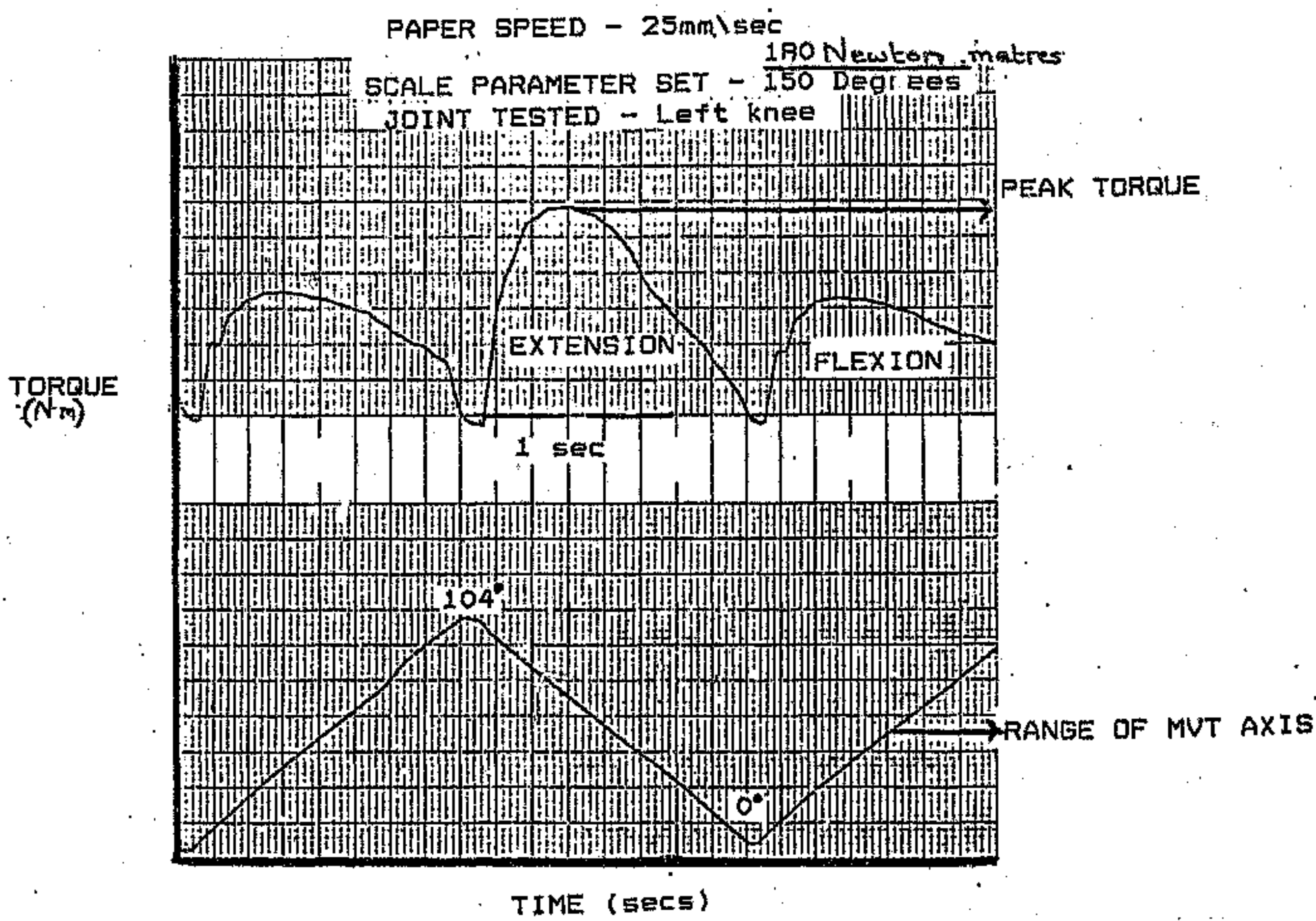

Fig 6 : Graphical printout of a Cybex II muscle strength analysis test.

CHAPTER 3 ANATOMY OF THE ANKLE

3.1 INTRODUCTION

The mature ankle and foot is a complex unit composed of twenty six bones that can bear the full body weight on standing and is able to transport the human body over all kinds of terrain.

3.2 THE LIGAMENTS OF THE ANKLE

Stability of the ankle joint is secured passively in part by the shape of the bones that make up the joint - ie. the distal part of the tibia with the medial malleous, the trochlea of the talus and the lateral malleolus, and partly by the ligamentous structures around the ankle.

Structures surround the joint laterally, medially and between the distal portion of the tibia and fibula. These comprise 3 groups :

(a) medial stability is secured by the medial collateral or deltoid ligament;

(b) lateral stability is secured by the lateral collateral ligaments;

(c) the internal structures of the ankle joint are secured by the distal tibiofibular syndesmosis ligaments.

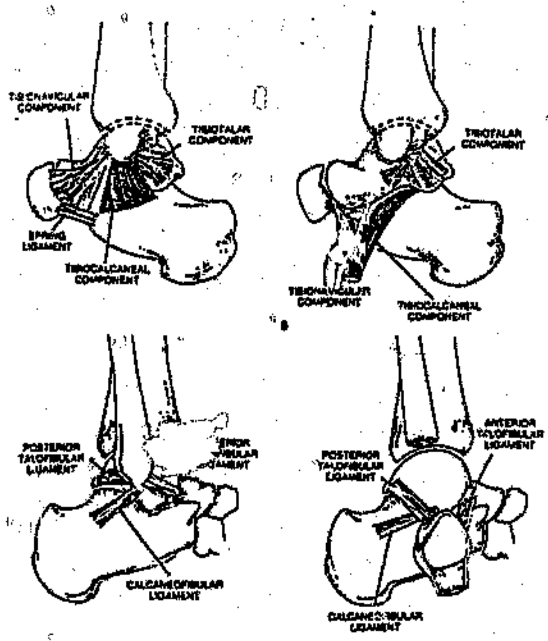

Fig. 7 : The Tibial and Fibular collateral ligaments of the ankle.

(From Kelikian 1985, p.20)

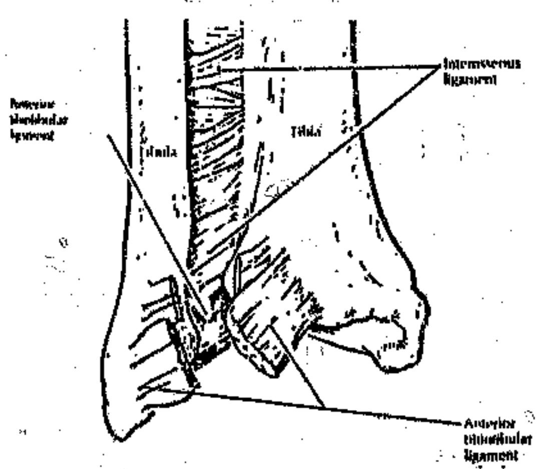

Fig. 8 : The distal tibiofibular syndesmosis ligaments.

(From Saunders 1980, p. 133)

3.3 FUNCTIONS OF THE ANKLE LIGAMENTS

The specific role of the individual ligamentous structures in ankle stability remains uncertain.

It has best been elucidated in the case of the lateral collateral ligaments, but even here it is difficult to draw definite conclusions owing to differences in techniques, methods and variations used by previous researchers.

The most striking movements of the ankle are known as dorsiflexion and plantarflexion. The movements occur about an axis which passes transversely through the body of the talus. The lateral end of the ankle axis passes through the tip of the fibula and is centrally located between the attachment of the lateral collateral ligaments, allowing them to remain taut during all movements. At its medial end, the transverse axis is placed eccentrically to the point of attachment of the medial ligaments. In this situation, the posterior medial ligaments become taut on plantarflexion. This arrangement of alternating tightness and slackness restricts the range of dorsal and plantar motion of the ankle (Cailliet, 1968).

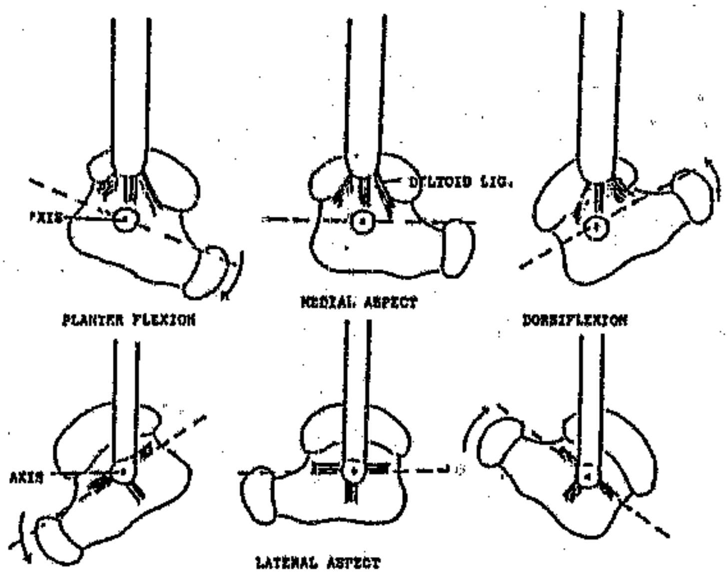

Fig. 9 : Relationship of medial and lateral ligaments to the axis of ankle motion.

(From Cailliet 1968, p. 8)

The most severe ankle injuries sustained in sports are of the abduction-external rotation type, in which the talus twists and pries the fibula from the tibia. Either the fibula itself fractures or the anterior talofibular ligament (ATFL) ruptures, producing widening of the tibiofibular ligament syndesmosis. In either event, as the force continues, the deltoid ligament gives way (or, more rarely in young men, pieces of the medial malleolus of varying sizes are avulsed) and the joint space between the talus and the medial malleolus can be seen to be wider than the horizontal component of the ankle joint.

Fracture accompanies ligament rupture more often than not, and the type of fracture, as Lauge-Hansen (1950) has pointed out, is the most valuable key to diagnosis.

Internal-rotation-adduction forces can stretch only the fibula-collateral ligament, the others being compressed, and then only if the characteristic horizontal avulsion fracture of the lateral malleolus does not occur.

3.4 SUMMARY

The ankle's movements in sport are complex and involve a shift of weight in the balanced action between trunk, knee, hip, ankle and foot. The ankle must maintain a balance on fixed surfaces such as ice or water, and absorb impact on uneven surfaces. In kicking, the ankle develops intense momentum to transfer the body to the foot and the resulting kinetic energy to propel the ball. This synchronous movement requires a counterbalance thrust to the opposite ankle. The relationship between the ankle and the knee is important, but complex, for example, in place kicking, the instep and entire forefoot twist on a fixed knee with rotatory instability of the knee, the rotational forces are transmitted to the foot via the ankle, producing a sprain in the ankle ligaments (Muckle, 1971). Travers (1980) comments on the interrelationship between sporting technique and injury, and emphasizes the importance of accurate biomechanical analysis and assessment in the prevention of sport injuries.

CHAPTER 4 ANKLE SPRAINS

4.1 DEFINITION OF ANKLE SPRAINS

There are various ways in which ankle sprains have been defined. Some definitions have been based on purely physical signs and symptoms, and others on functional limitations. Saunders (1980) and O'Donoghue (1984) classify ankle sprains into three groups : First-, Second-, and Third-degree sprains.

(1) A first-degree sprain is a mild ligamentous injury, in which there is no instability and no demonstrable haemorrhage. Only some fibres are torn. There are no strength deficits or functional limitations.

(2) Second-degree sprains produce more tenderness, swelling and functional loss than a first-degree sprain. The functional loss occurs due to a tear of a portion of the ligament, although no demonstrable decrease in the strength of the ligament is noted. There is some swelling and haemorrhage present and a slight decrease in range of movement.

(3) Third-degree sprains are severe - there is complete separation of the ligament, resulting in total loss of its function. There is marked swelling and gross haemorrhage.

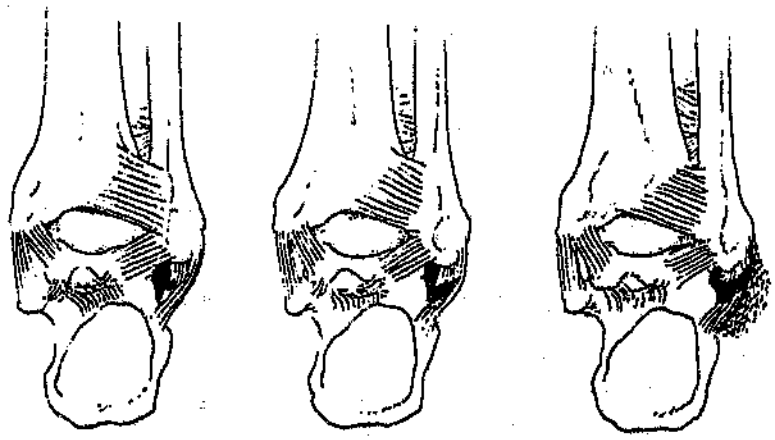

Fig. 10 : Drawings showing A) First-degree sprain, B) Second-degree sprain and C) Third-degree sprain.

(From O'Donoghue, 1984, p. 618)

Freeman et al (1965) used proprioceptive deficits to determine the degree of sprain. They used a modification of Romberg's test, where the patient was asked to stand first on the uninjured foot with his/her eyes open and then with his/her eyes closed, and then repeat this sequence on the injured side. Any discrepancy between bilateral ankles with regard to balance, was the identifying factor.

Cox and Brand (1977) have found the most useful test to be the "anterior drawer" manoeuvre, where the heel is gently manipulated back and forth in the sagittal plane (to detect excess movement). Rubin and Witten (1960) favour the popular radiological method of evaluating lateral ligament injury, by measuring the deqree of talar tilt on stress roentgenograms:

(1) First-degree sprain - 0 - 4 degrees subtalar tilt
(2) Second-degree sprain - 5 - 15 degrees subtalar tilt
(3) Third-degree sprain - 15 degrees subtalar tilt

Hocutt et al (1982) graded their sprains according to the functional limitations of the patient:

(1) Mild pain, able to run and jump with mild to moderate discomfort.

(2) Able to walk, climb stairs, jump with mild to moderate discomfort.

(3) Able to stand only without pain, climbing stairs and walking are greatly limited because of pain.

(4) Unable to stand or weight-bear because of pain.

(5) Complete or near complete tear. Weight-bearing impossible - surgery indicated.

For the purpose of this study, the following criteria had to be fulfilled in order for any player to have reported a positive ankle sprain in the study:

(1) An inversion or eversion strain.

(2) Pain and tenderness over the lateral and/or medial ligament.

(3) Withdrawal from at least one game or practise session.

The definition had its limitations insofar as there was no x-ray report taken into account and therefore associated fractures could not have been excluded in all cases.

4.2 CAUSES OF ANKLE SPRAINS

A clear appreciation of the manner in which a disease or condition develops is of paramount importance in its prevention and diagnosis.

This is particularly important in the prevention, diagnosis and management of sporting injuries, where a detailed and accurate understanding of the aetiology of a particular injury is needed.

In sports medicine, most sports injuries are caused not by a single factor, but actually a combination of factors present, for example a previous injury in the same knee which was inadequately rehabilitated, resulting in an overall weaker leg and weaker ligaments, could be an additional factor. There may be many factors associated with sports injuries (Keller, 1987):

(1) Training errors, eg. changes in intensity or duration of training.

(2) Errors of technique, with particular reference to changes in technique.

(3) Anatomical malalignment (decreased turnout, knock or bow knees, pes planus or cavus).

(4) Muscle-tendon imbalance, eg. weak anterior muscles, poor vastus medialus.

(5) Playing surface.

(6) Poor nutrition (crash diets).

(7) Psychological factors (social or family problems).

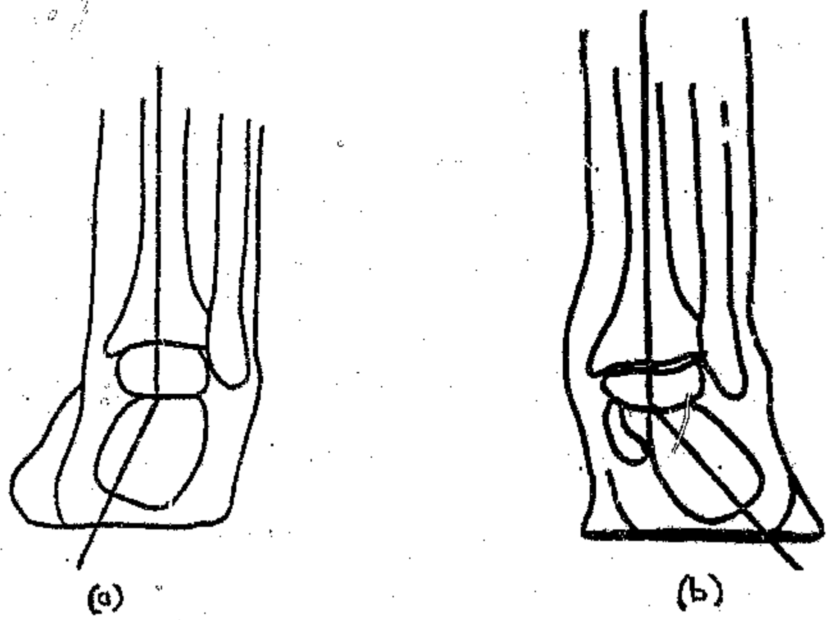

Fig. 11 : A pes cavus (a) and pes planus foot (b).

(From Franco, 1987, p.688)

In a one year prospective study of soccer injuries in Swedish senior men (Ekstrand, 1983a), 184 (72 percent) of the 256 injuries were associated with one or more of the injury factors identified in table 1.

TABLE 1

SOCCER INJURY RISK FACTORS (EKSTRAND, 1983b)

Type	Number of injuries*	Percentage of total injuries*
Player Factors	109	42
Lack of Training	6	2
Inadequate Rehabilitation	44	17
Joint Instability	31	12
Muscle Tightness	28	11
Equipment Factors	44	17
Playing Surface	62	24
Rules Violation	31	12
Other Factors	72	28

*Columns are not additive, as multiple factors frequently contribute to single injury.

Ekstrand (1983b) found that a history of a previous ankle sprain was twice as frequent among players sustaining a new ankle sprain, as among players without ankle injury. They concluded that inadequate healing and rehabilitation predispose players to recurrent or new injuries due to altered muscle strength, flexibility, cardiovascular endurance, balance and co-ordination.

Walsh (1977) highlights the two main causes of injury of the ankle, as being footwear and playing surface. They explain that wearing of proper or improper athletic footwear to include four general considerations:

(1) Shoe-surface interface.

(2) Shoe component and construction.

(3) Shoe size and fit.

(4) Shoe-layer interface.

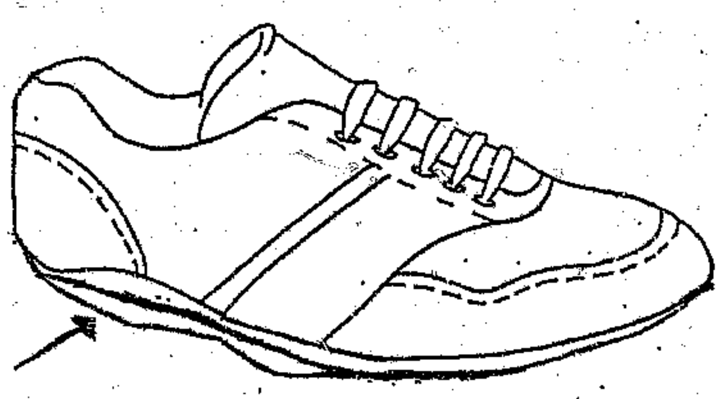

Fig. 12 : Improper Footwear.

Regarding the playing surface as a factor, they considered, artificial turf versus natural turf. For every report of decreased injuries on artificial turf, a contradictory study exists showing increased or unchanged rates of injury. On the same subject, Ekstrand and Gillquist (1983a) add that poor field conditions were judged to contribute to a quarter of all the recorded injuries in their study. They propose irregularity in the playing surface and varying weather conditions, as the primary factors responsible for ankle injuries.

Clement and Taunton (1981) propose five vital etiological factors that must be taken into account, if running injuries are to be prevented:

(1) Training methods.

(2) Training surfaces.

(3) Muscle disfunction and inflexibility.

(4) Shoe design.

Rinaldi et al (1979) state that anatomical malalignment as well as a tight Achilles tendon are largely responsible for ankle sprain injuries. In a study done on thirty one patients with lateral ankle sprains, 68 percent (or twenty one patients) were found to have a variety of anatomical malalignments, examples of which were :

(1) Valgus of the forepart of the foot.

(2) Varus of the rear of the foot.

(3) Leg length discrepancy.

All these malalignments were particularly associated with inversion ankle sprains that place the foot in an equinus and inverted position, in which the athlete is more likely to roll over onto the foot, injuring the anterolateral ligamentous structures of the ankle. Rinaldi et al (1979) further state that with a tight Achilles tendon the foot tends to be more plantarflexed, increasing the tendency for the foot and ankle to roll into inversion. This is especially the case for basketball and volleyball players. Walsh et al (1977) report that Achilles tendon tightness is a major cause of lateral collateral sprains of the ankle in athletics.

Tropp et al (1984) found that impaired postural control as demonstrated by pathologic stabilometric results, predicted future ankle injuries. They suggest that functional factors such as muscular atrophy and impaired postural control are important in the development of functional instability, and a predisposition to recurrent sprains.

Ferguson (1973) states that weak calf muscles are one of the most important causes of ankle sprains. The rolling motion of the subtalar joint inverts and everts the foot and acts as a "safety valve" for the ankle joint as well as the knee. Weak peroneal muscles would impair this function and thus make the ankle vulnerable to sprains. Freeman et al (1965) propose another reason for ankle instability; that of motor inco-ordination, which is consequent upon articular de-afferentiation.

Sporting activity is often complex and is a combination of controlled, often complex, physical and psychological activities. It is only by detailed appreciation of the complexities of individual sporting activity, coupled with a detailed understanding of factors leading up to an individual injury, that one can arrive at a correct diagnosis, which in turn is vital to expeditious treatment and restoration of full function.

4.3 MECHANISM OF SPRAINS

The mechanisms of ankle sprains are not well recognised (Dias 1979), and opinions differ regarding the mechanism and severity of ligament tears (Vaes et al, 1985). Pure valgus and varus injuries to the ankle would seem rare in athletic endeavours. An active participant on the athletic field is most likely to encounter an unforeseen disruption rapidly converted by a turn into lateral motion across the playing field. If this disruption occurs, it may be influenced by an irregular playing surface, a poor fitting shoe or a sudden interruption of the sequence by an opposing tackle. The major weight-bearing surface is the forefoot. It is about the forefoot that the entire body rotates when the player changes his direction. If at the moment of direction change, the running player loses his balance, or is interrupted by an external force, the foot will rotate into supination or pronation. The body having changed its forward momentum to an angular moment, then rotates about a fixed forefoot which is abnormally placed: the energy of forward motion is then translated into angular movement being applied directly to the fixed lower extremity.

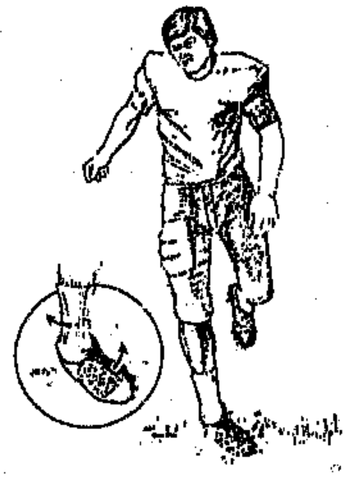

Fig. 13 : Rotation about fixed forefoot.

(From Guise 1976, p. 5)

The resultant force is more than which a normal ankle structure can absorb (Guise, 1976).

Dias (1979) has shown that the foot position is an important element in the mechanism of injuries, as well as the direction of abnormal force being transmitted to the ankle joint. Inversion and plantarflexion can be considered abnormal motions in the ankle mortise when they are beyond the normal anatomical limits. Internal and external rotation of the foot are essentially abnormal motions.

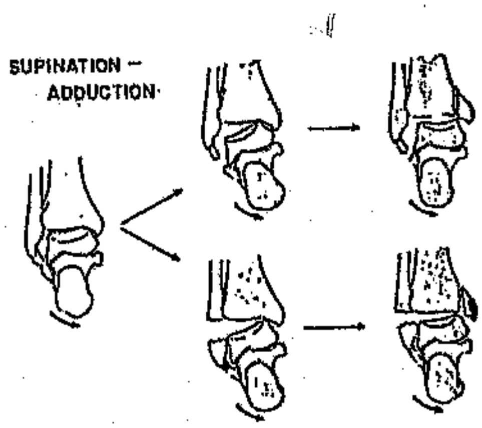

Fig. 14 : Mechanism of ankle sprains.

(From Quigley 1959, p. 122)

Rasmussen (1983) has done a lot of research with regard to the mechanisms of ankle sprains and the resultant tears of the various ankle ligaments. In dorsiflexion traumas, the injury affects mainly the medial collateral ligaments, and in plantarflexion traumas, the lateral ligaments.

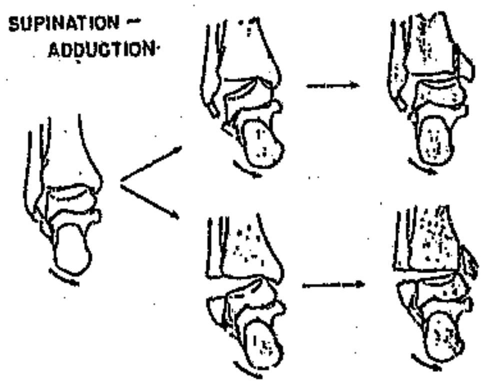

Fig. 14 : Mechanism of ankle sprains.

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Rasmussen (1983) has done a lot of research with regard to the mechanisms of ankle sprains and the resultant tears of the various ankle ligaments. In dorsiflexion traumas, the injury affects mainly the medial collateral ligaments, and in plantarflexion traumas, the lateral ligaments.

In internal rotation traumas, rupture of the ATFP and the short fibres of the posterior talofibular ligament (PTFL) may occur, even though the calcaneo-fibula ligament (CFL) remains intact. In adduction traumas the CFL may rupture first, possibly together with the short fibres of the PTFL, while the ATFL may remain intact. In external rotation traumas, the deep part of the deltoid ligament may rupture before its superficial part. In abduction traumas, the superficial part of the deltoid ligament may rupture while its deep part remains uninjured.

Dias (1979) has described a progression of tears of the ankle ligament with regard to the mechanism of ankle injury. (Table 2)

TABLE 2

PROGRESSION OF ANKLE SPRAINS (DIAS 1979, p.267)
I- Supination-inversion
A. Ankle in plantar flexion
Stage 1 - Rupture AFTL
Stage 2 - Rupture FCL
Stage 3 - Rupture PFTL (partial)
B. Ankle in neutral
Stage 1 - Rupture FCL (partial)
Stage 2 - Rupture FCL and AFTL
II- Supination-internal rotation
Stage 1 - Rupture ATFL
Stage 2 - Rupture FCL and PFTL
III- Supination-plantarflexion
Stage 1 - Rupture AFTL
Stage 2 - Rupture FCL (partial) and deltoid (partial)

From the above information, it becomes evident that there is some correlation between the mechanism of ankle injury and the structures involved, although the exact pattern of frequency is still somewhat in doubt.

CHAPTER 5 THE USE OF THE CYBEX II DYNAMOMETER* AS AN ADJUNCT IN THE MANAGEMENT OF ANKLE SPRAINS

5.1 INTRODUCTION

There has been much written on the use of the Cybex II Dynamometer in the field of sports medicine, but little done on its usage specifically in the area of rehabilitation. To date, there has been no documented study done comparing the rehabilitation of ankle sprain injuries using the Cybex II, with conventional physiotherapy techniques and modalities.

The null hypothesis examined in this study was that the Cybex II, when used in conjunction with other conservative methods of physiotherapy treatment for ankle sprain injuries, will not shorten the rehabilitation time.

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* Cybex II, Humex Inc, 100 Spence St, Bayshore, NY 11706

5.2 BACKGROUND

Garrick (1981) included isokinetic training in his ankle sprain rehabilitation programme. He suggested using the Cybex II to compare the range of movement and strength between bilateral ankles, during various stages of rehabilitation. Nickson (1987) and Wong et al (1984) have presented documented literature of normative isokinetic data for the ankle inverters and evertors, whereas Falkal (1978), Fugl-Meyer (1981) and Shields (1978) have presented similar data with reference to plantarflexor and dorsiflexor values. They emphasised the significant effect of both bodyweight and sex on absolute peak torque values, when analysing their results. Pierre et al (1984) used the Cybex II in the evaluation of various ankle ligament reconstructions. The main contributor to the field of Cybex II rehabilitation has been George J. Davies and his colleagues. They have documented various ankle sprain rehabilitation protocols, and the Cybex II protocol in this study has been based on their studies (Davies, 1985).

When reviewing the sports medical literature regarding the ideal way of treating ankle sprains, many conflicting ideas emerge. Ruth (1961) reported that two thirds of ankle sprains treated with immobilization had mechanically stable ankles, while Hughes (1983) found that ankle sprains treated with mobilization do not commonly lead to persistent mechanical instability.

Freeman (1965a) concluded that only suturing of the torn ligaments and immobilization guarantee final mechanical stability. He also found that mobilization produced the most unstable ankles, but immobilization in the Plaster-of -Paris cast led to results that were little better. He concluded that the crucial variable upon which final mechanical stability of the ankle depends, is not whether the ankle is immobilized or not, but whether or not the ends of the ruptured ligaments are initially in apposition.

Over the last fifty years, much of the work done on the subject of ankle sprains has been on the myriad of treatment methods and modalities (Henning 1977, Cyriax 1975, Quillen 1982). The acute stage of the injury (the first twenty four hours) is most commonly managed by the P.R.I.C.E. method : Protection, Rest, Ice, Compression and Evaluation. In the subacute stage (two to seven days), mobilizations, active range of movement exercises, stretching, taping, cross frictions and weight training, form the mainstay of treatment (Fig. 15 - 18).

In the chronic state (seven days onwards), balance board activities, resistance exercises, cycling and functional rehabilitation aimed at sp c sporting needs, form the mainstay of treatment (Brand 1977, Bergfeld 1982, Allen 1985). In devising the rehabilitation programme in this study, the methods mentioned thus far were all employed. (See Table 3).

In the chronic state (seven days onwards), balance board activities, resistance exercises, cycling and functional rehabilitation aimed at specific sporting needs, form the mainstay of treatment (Brand 1977, Bergfeld 1982, Allen 1985). In devising the rehabilitation programme in this study, the methods mentioned thus far were all employed. (See Table 3).

Fig. 15: Calf muscle stretching

Fig. 16: Hopping over the rope

Fig. 17: Elastic resistance exercises

Fig. 18: Ultrasound application

Fig. 15-18 : Examples of conservative physiotherapy methods for the treatment of ankle sprains.

TABLE 3

REHABILITATION PROGRAMME OF ANKLE SPRAINS

ACUTE STAGE	SUB-ACUTE STAGE	CHRONIC STAGE	
P - protection - crutches (as required)	Balance board training	Balance board training	
R - rest from activity	* Elastic resistance exercises	Calf stretching	
	* Gentle calf stretches	Elastic resistance exercises	
* I - ice	* Cycling	Heel and toe walking	
* C - strapping	* Heel walking	cycling	
* E - Elevation (at home at during treatment as far as possible.)	* Toe-walking	Hopping over a rope forward / sideways	
	Mobilization techniques as required		
M - mobility exercises while ankle is in elevation	Electrotherapy modalities as required	Running between beacons Sprints and quick directional changes	CYBEX TEST AS DISCHARGE CRITERIA
Gentle mobilization techniques as required	Cross frictions	Skipping	
	* Strapping	Four-square rehabilitation	
Ultrasound Interferential Curapulse Contrast baths — Electrotherapy modalities used as required		Retraining specific sporting actions	
Proprioceptive Neuromuscular Facilitation (PNF) static exercises			
Cross frictions			
CYBEX II DYNAMOMETER TRAINING (GROUP A ONLY)			

* Home as well as treatment exercises

5.3 METHODOLOGY

5.3.1 SUBJECT SELECTION

The patients included in this study were those referred to the physiotherapy out-patient department of the Johannesburg Hospital with a diagnosis of a Grade I or Grade II ankle sprain (see Chapter 4 for definitions) by the orthopaedic out-patient department of the hospital. Patients were excluded from the study if they reported a previous medical history of surgery to the injured ankle, deformities or a previous arthritic condition.

The patients were divided equally using random number tables into an experimental group and a control group. The physical characteristics of the two groups are shown in Table 4.

TABLE 4

CHARACTERISTICS OF TOTAL SAMPLE (N = 46)

Group Characteristics	Group: Experimental (n=23)	Group: Control (n=23)
Mean age in years	25.4 (17-45)*	24.7 (17-38)*
Number of female subjects	10	4
Number of male subjects	13	19
Average height (m)	1.66 (1.60-2.26)*	1.62 (1.56-2.10)*
Body weight (Kgs)	76.6 (63.2-100.1)*	74 (65.3-98.2)*

* The figures in brackets represent the range of values

5.3.2 EXPERIMENTAL DESIGN

Those patients in the control group received the usual conservative methods of physiotherapy treatment for ankle sprains (Table 3). The experimental group patients received the same methods as the control group, but in addition participated in a strength and power endurance programme on the Cybex II Dynamometer. All patients were required to report daily for treatments in the first week following their injury and then three times per week on alternate days until discharge.

The Cybex programme consisted of the patients being placed on the exercise table (as described on page 64) and performing the various stages of resistive exercise progression continuum as described by Davies (1985) (see fig. 19).

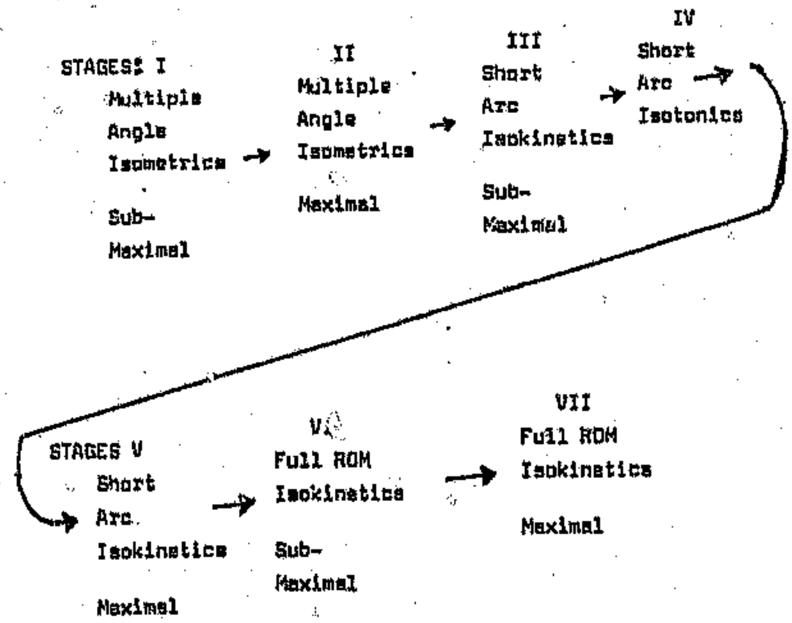

Fig. 19 : An example of resistive exercise progression continuum.

(From Davies 1985, pg. 74)

Short arc isokinetic exercises performed at intermediate contractile velocities (60 - 180 degrees/second) were implemented using a velocity spectrum rehabilitation programme (VSRP) in the subacute stage of treatment (fig. 20), while full range movement isokinetic exercises (180 - 300 degrees/second) were instituted in the chronic stage using the VSRP principle, until discharge.

180 ____________NO RF ____________ 180

150 10 repetitions 150

120 at each speed 120

90 90

60 degrees/sec 60

Start One VSRP - 100 repetitions Finish

Fig. 20 : An example of the velocity spectrum rehabilitation programme (VSRP).
(From Davies 1985, pg. 81)

All the patients were exercised under direct supervision, and were encouraged to train to their maximum on all exercises.

5.3.3 DISCHARGE ROUTINE

As soon as patients in either of the groups fulfilled the discharge test requirements (see next page), and exhibited minimal swelling and full, painfree range of ankle joint mobility, they were tested on the Cybex II Dynamometer. The Cybex tested the strength and power-endurance values of the uninjured compared to the injured ankle at three speeds, 60, 120 and 180 degrees per second. A computer readout with graphical analysis exhibited the results of the bilateral comparison (see fig 6). It was not possible to obtain base-line readings of bilateral ankle comparisons when the patient first presented for rehabilitation, as in most cases there was far too much swelling and pain in the acute and sub-acute stages to be able to rely on a valid comparative test.

As a result of the work of Wong et al (1984) which showed no statistical difference in strength between the dominant and non-dominant ankles of uninjured athletes, all subjects were discharged when they fulfilled all the following discharge criteria:

1. No significant difference ($P \leq 0.05$) in ankle strength (measured in Newton metres of torque) between injured and uninjured limbs, as tested on the Cybex II Dynamometer (Elliot, 1978).

2. Pain free on hopping and sprinting.

3. Pain free on quick directional changes.

The discharge date of each subject was then recorded on a chart. Full explanations were given of the procedures involved, and all patients signed informed consent forms.

5.3.4 STATISTICAL ANALYSIS

Both categorical and continuous variables were considered. In the former case, when 2 x 2 tables were analysed, use was made of the Yates corrected Chi-square test (Y) (Siegel, 1956), and when the sample was too small, Fisher's exact test (F) (Siegel, 1956) was employed. For higher order tables, Pearson's Chi-square test (P) (Siegel, 1956) was employed, provided the conditions of the test were met.

For the latter, use was made of a one-way analysis of variance (Anova) (Neter et al, 1982), which is equivalent to Student's T-Test (T) when only two groups are involved. Here, when the conditions of the test were not met, the non-parametric procedures of Kruskal-Wallis (KW) (Siegel, 1956) and Mann-Whitney (MW) (Siegel, 1956) were employed. The level of significance throughout the three parts of the study was set at five percent ($p \leq 0.05$).

5.4 RESULTS

Of the twenty three participants in both the experimental and control groups, seventeen successfully completed the rehabilitation programme in the experimental group, and eighteen in the control group. There was no statistical difference between the two groups with respect to:

1. Age distribution ($p>0.05$;T)
2. Sex distribution ($p>0.05$;Y)
3. Nature of injury distribution ($p>0.05$;P)
4. Grade of injury ($p>0.05$;Y)

The mean rehabilitation period for the experimental group was 27.7 (SD=6.17) days, compared to 39.2 (SD=7.05) days for the control group. There was no statistical difference between the two groups with respect to their mean rehabilitation times ($p>0.05$;T).

The mean time for rehabilitation (from initial referral to successful discharge), for the thirty five participants, was 34.6 (SD=8.74) days, with the shortest being fourteen days, and the longest fifty two days.

Twenty eight (60.9 percent) of all the ankle sprains reported were Grade II injuries, whereas eighteen (39.1 percent) were Grade I injuries.

5.5 DISCUSSION

Of the original forty six participants, eleven did not complete the study: some never returned after the initial examination, and some did not fulfil the discharge criteria of the rehabilitation programme.

When analysing the results, the experimental group was discharged 35 percent sooner than the control group (which from a rehabilitation point of view is of definite clinical significance). The hypothesis tested in this study, namely that isokinetic exercise added to conservative physiotherapy treatment decreases the period of rehabilitation in ankle sprain injuries, was rejected. Possible explanations for this may include the fact that Cybex II rehabilitation added to conservative physiotherapy treatment, may have resulted in "over rehabilitation". Overuse and/or overload during rehabilitation in the experimental group may have played a role in the final outcome.

It may have been preferable to use <u>only</u> the Cybex component in the rehabilitation programme in the experimental group. Ethical considerations, however, precluded this. There is also the possibility that active conservative treatment for ankle sprains may be sufficient for complete rehabilitation, with or without the inclusion of non-weight bearing accommodative resistance training in the form of the Cybex II. The human body may respond better to weight-bearing functional activities, rather than non-weight-bearing isokinetic exercise.

Although it must be expected that there are usually more Grade I injuries than Grade II sprains, the majority of these either do not report to a casualty department, or they are not referred for physiotherapy treatment.

5.6 RECOMMENDATIONS

The Cybex II may be used in place of one or more of the conservative physiotherapy treatment methods, and the total period of rehabilitation with the Cybex II (used by itself) could be compared with a treatment programme which excludes Cybex II rehabilitation. Ethical problems may however preclude such a study.

5.7 CONCLUSIONS

This study did not prove statistically that the Cybex II Dynamometer may be a useful additional rehabilitative method in the treatment of ankle sprain injuries. It may be necessary to design individual treatment protocols to suit the anatomical, pathological, psychological and psychosocial differences that exist between patients.

CHAPTER 6 THE PREVENTION OF ANKLE SPRAINS IN PROVINCIAL VOLLEYBALL PLAYERS - A CLINICAL TRIAL

6.1 INTRODUCTION

A review of the literature concerning sports injury prevention revealed that while there has been extensive work done on the conservative and surgical management of ankle sprains, little has been documented on their prevention. Considering the increase in athletic activities through recent years, ruptures in the ligamentous structures of the ankle joint may be assumed to constitute a growing problem, and in sports involving quick pivoting on a fixed foot, like volleyball and basketball, a high percentage of injuries will involve the ankle (Quigley, 1959). Moretz et al (1978) did a survey on 781 college and university men and women students, and found that volleyball had the highest number of injuries, of which sprains of the ankle were most common (Table 5).

The hypothesis tested was that a specially designed preventative programme could reduce the number of ankle sprains in a sample of provincial volleyball players.

TABLE 5

ANATOMIC LOCATION OF INJURIES IN AMERICAN COLLEGE AND UNIVERSITY STUDENTS (MORETZ 1978, p. 94)

	Boys	Girls
Upper Extremity	3	4
Back	0	2
Facial lacerations	0	4
Hip	0	2
Thigh	0	6
Knee	1	5
Leg	0	4
Ankle	3	13
Foot	1	3
Total	8	43

6.2 BACKGROUND

There have been no previously reported preventative trials in sports medical literature, involving volleyball players. Tropp et al (1985) studied two methods for the prevention of ankle injuries in soccer. The methods studied were ankle disc training (balance board training) and orthoses.

They concluded from their results that balance board training reduced the incidence of ankle sprains among players and that the ankle orthosis ought to be used before and during the sport season.

Walsh et al (1977) suggest that a good firm, even playing surface, Achilles tendon stretching, taping and proper footwear, all go a long way in preventing ankle sprains, while Wright (1979) concludes that mobility, endurance, strength and co-ordination should be the key factors in injury prevention.

Recently, more emphasis has been placed in strength training of the lower limbs, in order to prevent injury. Ferguson (1973) stresses that calf muscle build up is one of the most important measures in the prevention of ankle sprains. The rolling motion of the subtalar joint just beneath the ankle, inverts and everts the foot and acts as a "safety valve" for the ankle joint and knee, stabilized by the muscles of the calf. The non-slip character of artificial playing surfaces reinforces the need for this safety valve.

Flexibility and stretching exercises prior, during and after sporting activities, have found a place in sports injury prevention (Wright, 1979). Fitness comprises mobility, endurance, strength and co-ordination. The benefits of Achilles tendon stretching prior to a sports practice or game has been conclusively proven time and time again in both American high schools and at Universities (Moretz, 1978). With a tight Achilles, the foot tends to be in more plantarflexion, increasing the tendency for the foot and ankle to roll into inversion.

Most of the literature concerning the prevention of ankle injuries involves the use of taping or strapping, although as much literature as there is to show the beneficial effects of prophylactic taping, so are there as many arguments against the method (Garrick and Requa, 1973).

Adhesive strapping has been used to support ankles for more than one hundred years (Libera, 1972). Athletic trainers, coaches and team physicians have traditionally used adhesive strapping to limit the amount of inversion available to the athlete at extremes of motion. The indications for taping are based on the assumption that some type of external supportive material increases ankle stability by reinforcing the ligamentous structures of the ankle joint and restricting motion, such as extreme inversion, which is the culprit in most ankle injuries (Hughes, 1983).

Williams (1965) indicated that the use of ankle strapping is inappropriate since an artificial supports prevents adequate development of supportive musculature. He also suggests that the stress to a taped ankle which would result in a minor ankle injury if the joint were not strapped, is amplified and transmitted to the knee joint and would result in an increased probability of severe injury at that joint (fig. 21).

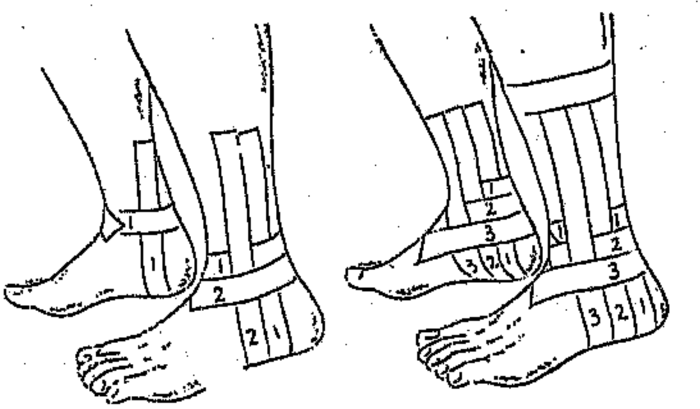

Fig. 21: Ankle strapping techniques.

As can be seen from the above studies, many preventative techniques have been suggested to prevent ankle sprains, but as yet, no uniform consensus exists supporting one method over another.

6.3 METHODOLOGY

6.3.1 TEAM AND SUBJECT SELECTION

This study was conducted throughout the 1987 South African Provincial Volleyball season. Eighteen of Transvaal's top male provincial players (six out of a possible twenty four provincial players could not take part in the study) formed the experimental group, while twenty two out of a total of twenty five provincial level players from Natal and Western Province formed the control group (see Table 6). All the players were South African Caucasians. Provincial volleyball players were used as their level of play is relatively standard throughout the country and there is an equal number of player-games at provincial level throughout the country.

Provincial players tend to be highly motivated and proved to be very eager to participate. The study achieved 100 percent player compliance.

TABLE 6

PHYSICAL CHARACTERISTICS OF TOTAL SAMPLE IN STUDY

Group Characteristics	Group	
	Experimental (n=18)	Control (n=22)
Mean Age (yrs)	28.6 (21-36)*	26.6 (18-42)*
No. yrs at current level of play	7.56 (1-15)*	6.29 (1-21)*
Mean weight (Kgs)	83.6 (69.5-95.6)*	81.3 (72.4-93.6)
Mean height (m)	1.76 (1.63-2.03)*	1.73 (1.70-2.01)*

* The figures in brackets represent the range of values.

Provincial level volleyball is played indoors on flat, unchanging surfaces, with little variation in footwear amongst players. Other sports, like soccer or rugby would, due to the nature of the games, have added numerous variables into the above study.

6.3.2 EXPERIMENTAL DESIGN

In addition to their regular training sessions, the players in the experimental group reported twice weekly to the physiotherapy out-patient department of the Johannesburg Hospital, where the forty minute preventative programme was performed. This continued for the total eight month period of the 1987 season.

The duration of the programme as well as each of the individual preventative methods were discussed with all the players, and a consent form was completed by the players (APPENDIX I). A questionnaire (APPENDIX II) to establish any previous injuries, anatomical abnormalities, shoes worn, etc, was completed by the players in both the experimental and control groups before the study commenced. The control group did not undergo any specific preventative programme other than their usual warm up and fitness exercises, and were instructed to keep accurate records of any ankle sprains reported during the volleyball season. For the purposes of this study, a positive report of an inversion strain associated with pain and tenderness of the ligaments of the ankle, sufficient to cause withdrawal from the rest of the game or practise session, served as the definition of an ankle sprain. This definition had its limitations, as no grade of sprain was taken into account, nor were x-ray reports taken to eliminate any possible fractures.

The preventative programme was carefully designed to include most of the important aspects of any sports game which included pronounced lateral movements, namely flexibility, endurance, proprioception and strength (Wright, 1979). A summary of the preventative programme is shown in Table 7.

TABLE 7

SUMMARY OF EXPERIMENTAL PROGRAMME *

Name of exercise	Time (minutes)
Achilles Tendon Stretching	5
Balance Board Training	10
Hopping over Rope	5
Cybex Training Programme	20
TOTAL	40

* Performed twice weekly for eight months.

6.3.2.1 ACHILLES TENDON STRETCHING

For this study, the players had to stand approximately one metre away from a solid wall leaning forward, with their arms as supports onto the wall, maintaining erect torsos. They were instructed to keep their heels on the floor with their legs slightly apart throughout the stretching session They held a constant stretch for 2.5 minutes with their knees straight (to stretch the two-jointed gastrocnemius muscle) and then a further 2.5 minutes with their knees bent at a 40 degree angle (to stretch the one-jointed soleus muscles).

They were instructed to stretch only until they began to feel a stretch on their Achilles tendons and not into an uncomfortable stretch position (fig. 22).

Fig. 22 : Achilles Tendon Stretching.

6.3.2.2 **BALANCE BOARD TRAINING**

Balance board training followed immediately upon Achilles tendon stretching. The players were required to balance on a circular balance board (diameter = 95 cm) for five minutes in a frontal plane and then for five minutes in a sagittal plane on a single-planar balance board. They changed the plane turning the board 90 degrees to either side. They were instructed to maintain their balance on the board and to avoid rocking the board (fig. 23).

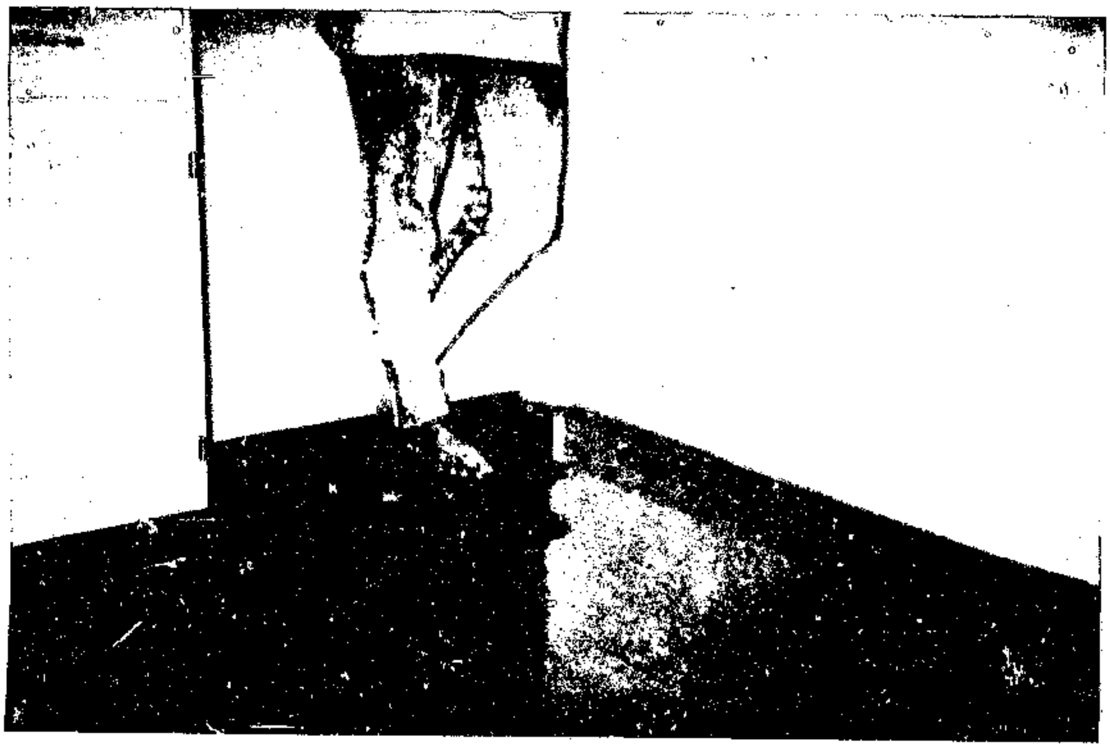

Fig. 23 : Balance Board Training.

6.3.2.3 HOPPING OVER THE ROPE

The hopping over the rope exercise followed immediately after balance board training. This method of prevention was specifically included to improve the jumping and endurance ability of the volleyball players. Each player was required to hop with both feet together from side to side over a rope suspended half a metre from the floor between two stools (fig. 24) for a total period of five minutes.

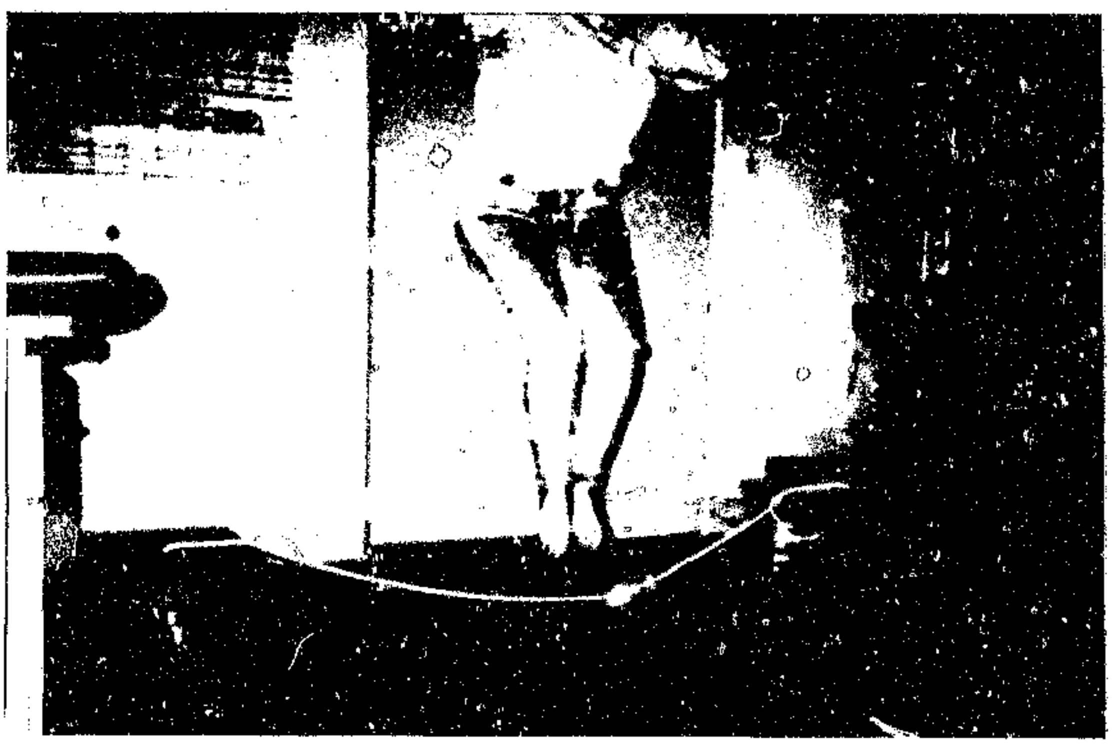

Fig. 24 : Hopping over the Rope.

6.3.2.4 THE CYBEX II DYNAMOMETER TRAINING ROUTINE

The players were all set up on the Cybex II Dynamometer and were instructed (with verbal encouragement) to complete the routine.

Each player was instructed to lie flat on the upper body exercise table (UBXT) with his hands holding the underside of the table. The seat of the UBXT was raised to the highest position while the dynamometer head was tilted back 55 degrees so that the axis of the dynamometer transected the superior edge of the lateral malleolus of the player.

The hip and knee of the tested leg were flexed at 55 degrees while the ankle was positioned in neutral plantarflexion and dorsiflexion. The pelvis was stabilized onto the UBXT by a Velcro strap, while the knee was stabilized to the knee pad with another Velcro strap. Three Velcro straps were used to stabilize the foot: one was applied around the front part of the head of the talus; one cross-strap was applied around the front part of the shoe near the metatarsophalangeal joints so that the under part of the strap would fix the shoe onto the footplate; a third strap was then applied around the forefoot on top of the cross strap. The subtalar joint was positioned in neutral position by palpating on both sides of the talar head. The subtalar joint was assumed to be at its neutral position when the talar head did not bulge out to either side of the navicular when the foot was moved through an arc of motion (fig. 25).

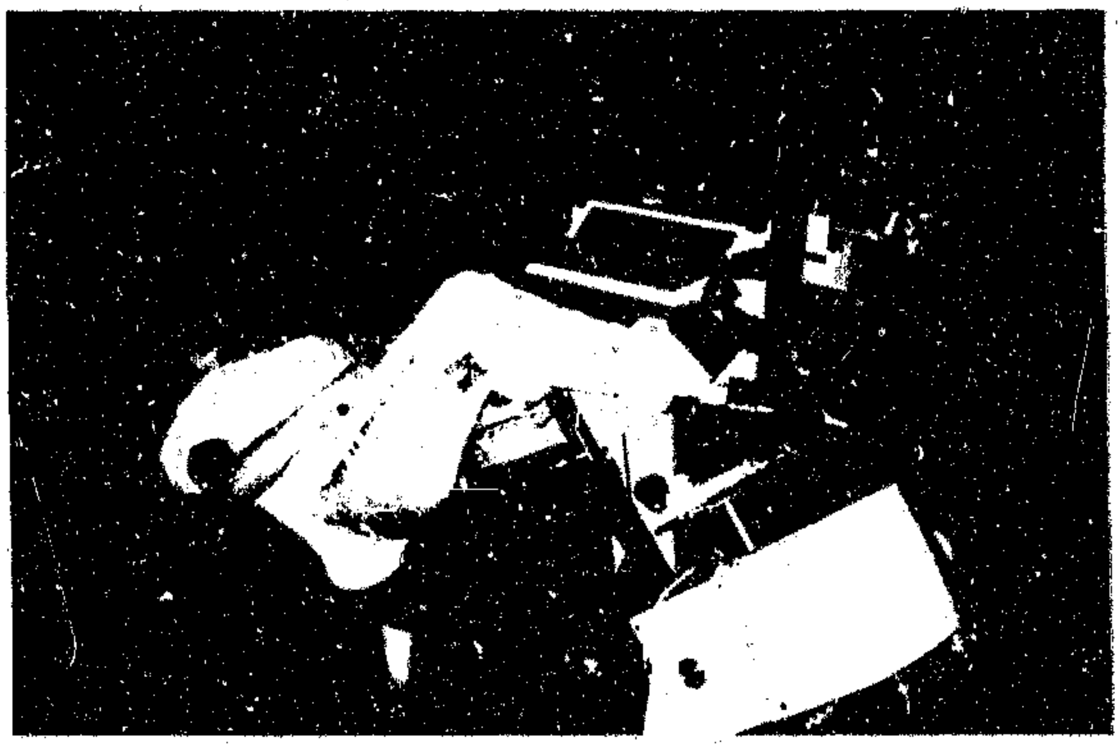

Fig. 25 : The Positioning on the Cybex II.

The players were instructed to perform the motions at the ankle and avoid accessory movements from the knee to the hip. Motion would start from full eversion to full inversion and then back to full eversion. The players all had to complete two circuits (on each ankle) of short arc isokinetic exercises as described by Davies (1985). They were instructed to rest for one minute between circuits (fig. 26).

180 ——— NO REST ——— 180

150 10 repetitions 150

120 at each speed 120

90 90

60 degrees/sec 60

Start One VSRP - 100 repetitions Finish

Fig. 26 : One circuit of short arc isokinetic exercises using a velocity spectrum rehabilitation programme (VSRP).

(From Davies 1985, p. 81)

At the conclusion of the 1987 provincial volleyball season, the total number of sprains reported, both in the experimental and control groups were collected and subjected to statistical analysis. The statistical methods employed were as described in Chapter 5, (5.3.4).

Most match and practice sessions of the experimental team were attended, in order to prevent under-reporting.

6.4 RESULTS

Table 8 exhibits some of the statistical comparisons between the two groups. None of these were significant.

TABLE 8

INTERGROUP STATISTICAL ANALYSES

Group Characteristics	p value
Age distribution	0.42;MW
Mean no. of yrs at current level of play	0.87;MW
No. of players wearing orthoses	0.32;F

Seven injuries were reported by the control team and two injuries by the experimental team. The difference between the two groups was marginally non-significant at the 5 percent level (P=0,059;MW).

No significance was found between the number of sprains reported and:

1. The age of the players (p=0.37;Anova)
2. The number of years at current level (p=0.58;Anova)
3. Application of orthoses (p=0.67;F)

A total of nine ankle sprain injuries were reported by both groups. This represented 22 percent of all the players. These injuries were reported at various intervals throughout the season, with no difference whether early, mid or late season.

6.5 DISCUSSION

The fact that one in five players in this study injured his ankle, highlights the very high percentage of ankle injuries in quick pivoting sports like volleyball. In a sport like volleyball, where the team consists of six players and a number of reserves, the withdrawal of players due to ankle injury has a large impact on the team.

Clinically, the proportion of sprains in the control group (7/22, 32 percent) can be regarded as higher than for the experimental group (2/18, 11 percent). However, the result was just not statistically significant (p=0.059;MW).

It is probably justified to assume that the experimental programme had some part to play in the marked reduction attained. Differences may well have become statistically significant if more subjects had been available.

The proposal that the efficacy of the preventative programme played a role in reducing the incidence of ankle sprains, was also suggested by the reduction in the incidence of sprains when comparing those reported in the experimental group between the 1986 and 1987 volleyball seasons. In 1986, eight sprains were reported by the experimental group (which consisted of the same players as the 1987 team), compared to two in 1987. When these figures were subjected to the McNemar's test of symmetry, the shift proved to be marginally non-significant (P=0,0588).

On subjective analysis, many of the players commented on various beneficial aspects that the programme had for them, including increased jumping power and increased ankle stability (APPENDIX II). It is not possible to analyse which aspect of the experimental programme may have been responsible for the reduction in injuries, as there were four consecutive parts to the programme and only by using each separately in another study, can this be determined.

RECOMMENDATIONS

The author therefore recommends that a further study be undertaken using a larger population sample over possible two or three seasons, using each part of the programme separately, or leaving the programme as it is.

It would be desirable for the achievement of more accurate results to use a study group in which there has been no previous ankle sprains, as previous history of injuries (major or minor) to the lower limb may well have confounded the issue and diluted the results. This, however, is a most unlikely possibility when using top level experienced players.

6.6 CONCLUSION

The hypothesis in this study had to be rejected. However, the results do reflect what could be a real probability, that preventative programmes can reduce the incidence of ankle sprains in provincial volleyball players.

APPENDIX I

C O N S E N T   F O R M

THE USE OF THE CYBEX II DYNAMOMETER AS AN ADJUNCT IN THE MANAGEMENT AND PREVENTION OF LATERAL ANKLE SPRAINS

I, ________________________________, freely and voluntarily consent to participate in a research program under the direction of ANTHONY KAPLAN to be conducted in the Physiotherapy Department of the Johannesburg hospital.

I understand that the Cybex II Dynamometer has been used extensively in the prevention of sports injuries around the world and has proved to be a valuable asset to sportsmen and women in their endeavours to improve their sporting performances. The purpose of this study is to ascertain whether the Cybex II Dynamometer used as an adjunct in the preventative programme, will reduce the number of ankle sprains in provincial volleyball players. Information gained from this investigation could aid in the detection of "at risk" players as well as the improvement of training schedules in order to prevent these injuries occurring.

A thorough description of the procedures has been explained, and I understand that the only risk involved is soreness of the contracting muscles that may last for the duration of the training programme.

I understand that I may withdraw my consent and discontinue participation in this research project at any time without prejudice to myself.

I authorise ANTHONY KAPLAN and the Department of Physiology to keep, preserve, use and dispose of the findings from this research with the provisions that my name will not be associated with any of the results.

I have been given the right to ask, and have had answered, any questions concerning the procedures to be used during this research.

Questions have been answered to my satisfaction. I have read and understand the contents of this form and have received a copy.

______________________	________________	____________________
Witness	Date	Participant

I have explained and defined in detail the research procedure to which the subject has consented to participate.

______________________	________________
Signature	Date

APPENDIX II

QUESTIONNAIRE

1. Name : ______________________

2. Age : ______________________

3. Team : ______________________

4. Position : ______________________

5. No. of years playing at present level : ______________________

6. Any previous sprains : (If NO, continue with 7.)

   Which ankle/s : ______________________

   ____

   When (year & month) : ______________________

   How : ______________________

   ____

   ____

7. Did you have physiotherapy :

   ____

8. Do you play with any ankle-protecting devices, if so, which kind :

   ____

   ____

   ____

9. Have you had any surgery on your ankle :

   ____

   ____

   ____

10. Have you any comments to make about the preventative programme or anything else connected with the research :

   ____

   ____

   ____

   ____

11. What kind of shoes do you play volleyball in ?

12. What other sports do you participate in?
How often?
At what level?

13. Have you got any ankle, knee or hip conditions ?
(e g flat-footed, bow-legged.)

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