A BIOKINETIC APPROACH TO THE PREVENTION AND REHABILITATION OF SHOULDER INJURIES IN TENNIS PLAYERS

by

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DEDICATION

This dissertation is dedicated to my husband!

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SYNOPSIS

TITLE	A Biokinetic Approach to the Prevention and Rehabilitation of Shoulder Injuries in Tennis Players.
CANDIDATE	Karien Gouws
PROMOTOR	Prof. P.E. Krűger
DEGREE	DPhil (MBK) Biokinetics

Sports scientists and trainers generally agree that the multidimensional training in tennis should start during early childhood in order to ultimately reach a professional playing standard. Evidence suggests that motor skills, including power, strength, agility, speed and explosive power, as well as mental strength and a highly developed neuromuscular coordinating ability are strongly correlated with the level of tournament performance. Turner & Dent (1996) found that 27% of all tennis injuries in junior players occur in the shoulder region. The shoulder girdle is prone to injury because of its ability to maximally accelerate and decelerate the arm while the arm maintains it maintains precise control over the racquet at ball contact.

The purpose of this study was to determine whether the occurrence of shoulder injuries could be minimized in tennis players by following a specific exercise programme, focusing on the shoulder girdle.

A total of 42 tennis players participated in this study. They were all aged between 14 and 18 years. Both males and females were used for the purpose of this study. All the players were training at the SA Tennis Performance Centre and the International Tennis Federation at the University of Pretoria. They were all elite tennis players practising daily and scheduled for standard major tournaments throughout the year.

Each subject completed a questionnaire of his or her tennis and medical history. The players were then divided into a control group and an experimental group. Both groups completed a series of physical scientific tests, consisting of posture analysis, body composition, flexibility, functional strength of the upper body; and isokinetic power and endurance of the shoulder muscles.

These tests were executed every 3 months over a 9-month period and the results of each battery of tests were used to adjust and upgrade the new programmes. The experimental group did specific preventative shoulder exercises 5 times a week in addition to their usual gymnasium programme twice a week, while the control group followed a normal strengthening programme twice a week. A medical doctor immediately evaluated any muscle stresses or pains throughout the year. At the end of the year the data was compared to determine the difference in injury occurrence between the two groups.

There was a significant difference ($p<0.05$) in the distribution of the **lean body** mass with the Lean body mass at T1 being lower than the Lean body mass at T3 in the c*ontrol group*. In the *experimental group* the **fat percentage** showed a significant decrease ($p<0.05$) from T1 to T3. The distribution of the **muscle percentage** at T1 was significantly different ($p<0.05$) from the distribution of the muscle percentage at T3 in the *experimental group* with the muscle percentage at T1 being lower than the muscle percentage at T3.

There was a significant difference between the *control* and *experimental group* for **1RM bench press** ($p<0.05$) with the 1RM bench press measurements at T3 being lower for the *control group* than for the experimental group. Also, the 1RM bench press at T1 was lower than the 1RM bench press at T3 in the *experimental group*. The experimental group showed a significant increase from T1 to T3, peaking at T3 with the 1RM bench press.

Results of the tests done to determine **isokinetic muscle strength** showed that a statistical significant correlation ($p<0.05$) was found with regard to the strength of the **internal rotators** of the non-dominant shoulder at T3, with the experimental group having a higher measurement than the control group. The **internal rotators** and **external rotators** of both the dominant and non-dominant shoulders were lower at T1 than at T3 in the e*xperimental group* ($p<0.05$). The **external rotators** of the non-dominant shoulder at T1 were lower than the external rotators of the non-dominant shoulder at T3 in the c*ontrol group*.

Results of the tests done to determine **flexibility** showed a statistically significant difference with the **internal rotators** and **external rotators** of the dominant as well as the non-dominant shoulders being lower at T1 than at T3 in the e*xperimental group*. Also, the external rotators of the non-dominant shoulder of the *control group* were lower at T1 than at T3.

Results of the tests done to determine **posture** showed that in the control group, 54.5% of the players had **scoliosis** at T1 as opposed to 40.9% at T3. In the *experimental group* 55% had scoliosis at T1 compared to the 30% at T3. In the experimental group, 55% of the players' **shoulder heights** were not level at T1, compared to 30% at T3. 63.6% of the control group's non-dominant shoulders were higher than the dominant shoulder at T1, compared to the 40.9% of subjects at T3. Among the subjects in the *experimental group*, 50% had a higher non-dominant shoulder and 5% a higher dominant shoulder at T1, compared to 25% and 5% respectively in the *control group*, at T3.

Results of the tests done to determine the occurrence of injuries, showed that the subjects with **no injuries** in the *control group* stayed stable from T1 (54.5%) to T2 (54.5%) whereafter it increased to 59.1% at T3. The experimental group stayed stable from T1 (55.0%) to T2 (55.0%) where after it increased to 85% at T3. In the *control group* the percentage **grade 1 and 2** injuries was 13.6% at T1, increasing to 18.2% at T2, and decreasing to 13.6% at T3. In the *experimental*

group 15% of the subjects had **grade 1** injuries at T1. This percentage increased to 30% at T2 where after it decreased to 15% at T3 again. The percentage of subjects with **grade 2** injuries in the *experimental group* remained stable at 10.0% from T1 to T2. None of the subjects had grade 2 injuries at T3. In the control group 9% had **grade 3** injuries at T1, with none at T2 and T3. In the experimental group the percentage of subjects with **grade 3** injuries remained stable at 5.0% from T1 to T2. None of the subjects had **grade 3** injuries at T3. In the control group 4.5% of subjects had **grade 4** injuries at T1. This stayed more or less stable at T2 (4.6%) and increased to 9.1% at T3. In the *experimental group* 10.0% had **grade 4** injuries at T1. None of the subjects had **grade 4** injuries at either T2 or T3. In the *control group* 4.5% had **grade 5** injuries at T1, none had it at T2, and 4.5% had it at T3. In the *experimental group* none of the subjects had **grade 5** injuries at T1, T2 or T3. In the *control group* none of the subjects had **grade 6** injuries at T1 or T3. At T2, however, 4.6% had **grade 6** injuries. In the *experimental group* 5.0% of the subjects had **grade 6** injuries at T1 and none had this type of injury at T2 or T3.

In conclusion, the results indicate that a specifically designed exercise programme can help to diminish the risk of shoulder injuries in tennis players. It can also improve bi-lateral muscle strength in opposing muscle groups which are used in tennis.

KEY WORDS: Tennis, shoulder injuries, training programmes, rehabilitation programmes, tennis strokes, biomechanics of tennis, elbow injuries, posture, skoliosis, muscle strength.

SAMEVATTING

TITEL	'n Biokinetiese benadering tot die voorkoming en rehabilitasie van skouer beserings in tennisspelers.
KANDIDAAT	Karien Gouws
PROMOTOR	Prof. P.E. Krűger
GRAAD	DPhil (MBK) Biokinetika

Sportwetenskaplikes en afrigters stem saam dat multi-dimensionele afrigting in tennis reeds tydens die vroeë kinderjare moet begin om sodoende 'n professionele standaard te bereik. Navorsing toon dat motorvaardighede soos krag, ratsheid, spoed en plofkrag asook breinkrag en 'n hoogs ontwikkelde neuromuskulere koördinasie vermoë 'n sterk ooreenkoms toon met prestasie in toernooie. Turner & Dent (1996) het bevind dat 27% van alle tennisbeserings in junior spelers in die skouerarea voorkom. Die skouergordel is baie vatbaar vir beserings as gevolg van sy funksie om die arm maksimaal te versnel en spoed te verminder terwyl die arm goeie beheer oor die raket uitoefen tydens balkontak.

Die doel van die eksperimentele studie was om vas te stel of skouerbeserings by tennisspelers verminder kan word deur 'n spesifieke oefenprogram te volg wat fokus op die versterking van die skouergordel.

In die studie is daar van 42 tennisspelers gebruik gemaak. Al die spelers was tussen 14 en 18 jaar oud. Beide seuns en dogters is gebruik vir die studie. Al die spelers het geoefen by die "SA Tennis Performance Centre" en die Internasionale Tennis Federasie by die Universiteit van Pretoria. Almal was elite tennisspelers wat daagliks geoefen het en geskeduleer was vir sekere groot toernooie deur die loop van die jaar.

Elke proefpersoon het ‘n vraelys voltooi rakende sy of haar tennis- en mediese geskiedenis. Daarna is die proefpersone in ‘n kontrole- en eksperimentele groep verdeel. Beide die groepe het ‘n reeks sportwetenskaplike toetse voltooi, bestaande uit postuur analise, liggaamsamestelling, soepelheid, funksionele krag van die bolyf, en isokinetiese krag en uithouvermoë van die bolyf.

Die toetse is elke 3 maande oor ‘n tydperk van 9 maande uitgevoer. Die resultate van elke reeks toetse is gebruik om die nuwe programme aan te pas. Die eksperimentele groep het 5 maal per week spesifieke voorkomende skouer oefeninge gedoen addisioneel tot hul gewone gimnasium program twee maal per week. ‘n Mediese dokter het alle spierpyne en beserings onmiddellik geevalueer reg deur die toetsperiode. Aan die einde van die toetsperiode is die data gebruik om die voorkoms in beserings tussen die twee groepe te vergelyk.

Daar was ‘n beduidende verskil ($p<0.05$) in die verspreiding van **vetvrye massa** met ‘n laer vetvrye massa by T1 (toets1) teenoor T3 (toets 3) in die kontrole groep. Die **vetpersentasie** van die *eksperimentele groep* het ‘n beduidende afname getoon vanaf T1 na T3 ($p<0.05$). Die verspreiding van **spierpersentasie** was beduidend laer in die *eksperimentele groep* tydens T1 teenoor T3 ($p<0.05$).

Daar was ‘n beduidende verskil tussen die *kontrole* en die *eksperimentele groep* se **1RM** (Een Maksimale Repetisie) borsstootkrag waardes ($p<0.05$). Die 1RM borsstootkrag van *die kontrole groep* was laer as die van die *eksperimentele groep* tydens T3. Die *eksperimentele groep* het ‘n beduidende toename getoon vanaf T1 tot T3 in 1RM borsstootkrag.

Die resultate van **isokinetiese spierkrag** dui op ‘n statisties beduidende korrelasie ($p<0.05$) vir die krag van die **interne rotators** van die nie-dominante skouer tydens T3, met die *eksperimentele groep* wat ‘n hoër waarde as die *kontrole groep* behaal het. Die **interne** en **eksterne rotators** van beide die

dominante and nie-dominante skouers was laer tydens T1 as T3 ($p<0.05$). Die **eksterne rotators** van *die kontrole groep* was laer by T1 as by T3.

Die soepelheidstoetse het getoon dat die **interne rotators** en die **eksterne rotators** van die dominante sowel as die nie-dominante skouers beduidend laer was tydens T1 as T3 by die *eksperimentele groep.* By die *kontrole groep* was die **externe rotators** van die nie-dominante skouer laer by T1 as by T3.

Die **postuur analise** dui daarop dat **skoliose** by 54.5% van die proefpersone in die *kontrole groep* tydens T1 teenwoordig was teenoor 40.9% tydens T3. By die *eksperimentele groep* het 55% **skoliose** gehad tydens T1 teenoor die 30% tydens T3. In die *eksperimentele groep* was 55% van die proefpersone se **skouerhoogtes** oneweredig in T1 teenoor die 30% in T3. In die *kontrole groep* was 63.6% se nie-dominante skouer hoër as die dominante skouer tydens T1 teenoor 40.9% tydens T3. In die eksperimentele groep was 50% van die proefpersone se nie-dominante skouer hoër en 5% se dominante skouer hoër tydens T1, teenoor 25% en 5% respektiwilik tydens T3.

Die resultate van die voorkoms van beserings, dui dat die persentasie met **geen beserings** in die *kontrole groep* konstant gebly het vanaf T1 (54.5%) tot T2 (toets 2) (54.5%) waarna dit toegeneem het tot 69.1% in T3. In die *eksperimentele groep* het die **geen beserings** ook konstant gebly vanaf T1 (55%) na T2 (55%) waarna dit toegeneem het tot 85% in T3. In die *kontrole groep* was die proefpersone met **graad 1 en 2** beserings 13.6% in T1, dit het toegeneem tot 18.2% in T2 en weer afgeneem tot 13.6% in T3. In die *eksperimentele groep* het 15% van die proefpersone **graad 1** beserings gehad met T1, dit het toegeneem tot 30% met T2 en weer afgeneem tot 15% in T3. Die **graad 2** beserings van die *eksperimentele groep* het konstant gebly met 10% tydens T1 en T2, met geen Graad 2 beserings tydens T3 nie. In die *kontrole groep* was daar 9% **graad 3** beserings tydens T1, en geen tydens T2 en T3 nie. In die *eksperimentele groep* het die **graad 3** beserings konstrant gebly met 5%

vanaf T1 tot T2, met geen **graad 3** beserings tydens T3 nie. In die *kontrole groep* het 4.5% **graad 4** beserings gehad tydens T1. Dit het min of meer konstant gebly met 4.6% tydens T2 en gestyg tot 9.1% met T3. Die *eksperimentele groep* het 10% **graad 4** beserings gehad tydens T1, maar geen tydens T2 en T3 nie. In die *kontrole goep* was daar 4.5% **graad 5** beserings tydens T1, geen tydens T2 nie en weer 4.5% tydens T3. In die *eksperimentele groep* was daar geen **graad 5** beserings tydens T1, T2 of T3 nie. In die *kontrole groep* was daar geen **graad 6** beserings tydens T1 en T3 nie, maar 4.6% van die proefpersone het **graad 6** beserings tydens T2 gehad. In die *eksperimentele groep* het 5% **graad 6** beserings gehad met T1, maar geen tydens T2 en T3 nie.

Om saam te vat, die resultate dui daarop dat ‘n spesifiek ontwerpte oefenprogram wel kan bydra om die risiko vir skouerbeserings te verminder. Dit kan ook help om die bi-laterale spierkrag in antagonistiese spiergroepe, wat in tennis gebruik word, te verbeter.

SLEUTELWOORDE: Tennis, skouerbeserings, oefenprogramme, rehabilitasie programme, tennis tegnieke, biomeganika van tennis, elmboogbeserings, skoliose, spierkrag.

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