行政院國家科學委員會專題研究計畫 成果報告

內側縱向足弓與反旋前貼布於垂直跳躍動作時對足部生物力學的影響

研究成果報告(精簡版)

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計 畫 主 持 人 ： 張怡雯
共 同 主 持 人 ： 許弘昌
計畫參與人員： 碩士班研究生-兼任助理人員：徐慧
碩士班研究生-兼任助理人員：張宏達
碩士班研究生-兼任助理人員：黃琪雅

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附件一

國家科學委員會補助專題研究計畫

■ 成 果 報 告
□期中進度報告

內側縱向足弓與反旋前貼布於垂直跳躍動作時對足部生物力學的影響

計畫類別：■ 個別型計畫　　□ 整合型計畫

計畫編號：NSC 97－2410－H－028－003－

執行期間：　97 年　8 月　1 日至　98 年　7 月 31 日

計畫主持人：張怡雯

共同主持人：許弘昌

計畫參與人員：　徐慧、張宏達、黃琪雅

成果報告類型(依經費核定清單規定繳交)：■精簡報告　□完整報告

本成果報告包括以下應繳交之附件：

□赴國外出差或研習心得報告一份

□赴大陸地區出差或研習心得報告一份

■出席國際學術會議心得報告及發表之論文各一份

□國際合作研究計畫國外研究報告書一份

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執行單位：國立臺灣體育大學(臺中)

中　華　民　國　98　年　9　月　14　日

摘要

本研究計畫主要探討不同的足部內側縱向足弓高度，對於跳躍運動與直接落地時生物力學的影響，並分析使用肌內效貼布對於動力學與肌電訊號的效益。本研究共招募了 34 位年輕女性受試者，拍攝在雙腳站立、單腳站立與未承重時的 X 光影像，經過計算分析舟狀骨高度差異值後，將受試者分為三組，旋前組、中間組與旋後組，並請每一位受試者分別作垂直跳與直接落地二種動作，同時加上肌內效貼布的使用，分別貼在腓腸肌、脛前肌與蹠內在肌。實驗設備為二塊力板與肌電訊號收集系統，同步收集地面反作用力與肌肉收縮訊號。結果顯示，在垂直跳躍時，旋後組(5.65%BW)比旋前組(4.56%BW)產生較大的地面反作用力。在直接落地動作中，旋前組(4.96%BW)與中間組(4.92%BW)比旋後組(6.44%BW)產生較小的地面反作用，旋後組(135.01%BW/sec)比中間組(87.69%BW/sec)有較大的負荷速率。在肌電訊號部分，在垂直跳躍的準備期時，與中間組(29.6%MVC)相比，旋前組(19.3%MVC)與旋後組(21.3%MVC)皆產生較小的股二頭肌的活動訊號，另外，在垂直跳躍的準備期，和赤足(41.4%MVC)相比，肌內效貼布於蹠內在肌(47.4%MVC)時，脛前肌有較大的肌肉活動性，這些差異都具有統計上的顯著性($p<0.05$)。因此，由研究結果發現，不同足弓變異程度確實會有不同的動力學表現，顯示足弓高低的變化，會改變對下肢的衝擊。且肌內效貼布的使用，對於高衝擊性的直接落地動作，也有一定的影響性，這些資料將可以提供運動醫學的臨床治療之參考。

關鍵字：內側縱向足弓、肌內效貼布、肌電圖、動力學、生物力學

Abstract

The purpose of this study was to analyze the biomechanics in the subjects with different foot type and to investigate the effect of kinesio tape on kinetics and electromyography (EMG) during vertical jump and drop landing. Thirty-four females participated in data collection of radiology. The testing conditions included non-weight bearing, single-limb stance and double-limb stance. Based on the X-ray findings, twenty-seven subjects were divided into three groups and were asked to perform vertical jump and drop landing. Kinesio tape on tibialis anterior, gastrocnemius and intrinsic plantar muscles were used. Force plates and EMG system were used to measure the ground reaction forces and muscle activities during vertical jump and drop landing. Supinated group (5.65%BW) showed significantly greater peak vertical ground reaction force in landing phase than neutral group (4.56%BW) during vertical jump, indicating the vertical ground reaction force was increased with greater deformation of medial longitudinal arch in landing phase of vertical jump. During drop landing, pronated group (4.96%BW) and neutral group (4.92%BW) showed significantly lesser vertical ground reaction forces than supinated group (6.44%BW). Supinated group (135.01%BW/sec) showed significantly greater load rate than neutral group (87.69%BW/sec). Also, during vertical jump, there was a significant difference in EMG activity of biceps femoris in early-preparatory phase between different arch groups. Supinated group (19.3%MVC) and pronated group (21.3%MVC) showed lesser EMG activity in biceps femoris than neutral group (29.6%MVC). Bare foot (58.3%MVC) showed lesser EMG activity in medial gastrocnemius than tape on tibialis anterior (62.6%MVC). Bare foot (41.4%MVC) showed lesser EMG activity in tibialis anterior than tape on intrinsic plantar muscles (47.4%MVC). Differences in lower extremity kinetics in individuals with different foot types may have implications for new treatment strategies or preventative measures.

Keywords: medial longitudinal arch, kinesio tape, electromyography, kinetics, biomechanics

Biomechanical Analysis of Kinesio Tape in the Individuals with Different Medial Longitudinal Arch Types during Vertical Jump and Drop Landing

Introduction

The foot is the first interaction part of the body with the ground and its structure will partly determine how much force is absorbed by the bones in the foot and how much force is transferred to proximal bones during ground contact (Cubukcu et al., 2005). Medial longitudinal arch is the largest and clinically the most important of the foot arches. The shape of the bone, the strong ligaments, especially those on the plantar surface of the foot, and the tone of the muscles all play an important role in supporting the arches.

Three foot types have been described according to structure of medial longitudinal arch: normally aligned or normal foot, low arched, pronated foot or pes planus and high arched foot or pes cavus (Cubukcu et al., 2005). The high arched or supinated foot is more rigid and less able to absorb shock, resulting in higher pressure underneath the heel and more force passing to the tibia and femur. The low arched foot with a greater contact area is more flexible, allowing stress to be absorbed by the musculoskeletal structures of the foot and associated with higher midfoot plantar pressure during walking (Morag and Cavanagh, 1999). High arched individuals are reported to have an increased number of tibial and femoral stress fractures while low arched subjects demonstrate a greater number of metatarsal injuries. Prolonged pronation or hyperpronation of a low arched foot can also induce a great amount of torsion on the tibia and may exacerbate muscle fatigue as the muscles have to work harder to control the excessive motion, especially at toe-off. Williams et al. (2001) also demonstrated that high-arched runner reported a greater incidence of ankle injuries, bony injuries and lateral injuries. Low-arched runners exhibited more knee injuries, soft tissue injuries and medial injuries. High and low arch structure is definitely associated with different injury patterns.

Various methods have been used to define and categorize arch structure. Visual observation has been proved to be unreliable (Cowan et al., 1994). Foot print measures give more opportunity to evaluate the arch dynamically but they may not characterize the bony architecture well (Williams et al., 2001). Williams and McClay (2000) reported that most reliable and valid measurements of bony structure of the arch may be the arch index, obtained by dividing dorsum height by truncated foot length. However, this technique for measurement of medial longitudinal arch is only limited in static condition (standing). In addition, many factors play a role in the development of injuries in the lower extremity. Foot structure is commonly associated with lower extremity problem. It is believed that one of the major functions in medial longitudinal arch is shock absorption, especially in high impact activity. Existence of foot arch could reduce the impulse generated from the ground reaction force.

Foot orthoses modify the way ground forces are transmitted to the foot and its internal structures. This is accomplished by producing surface contours on the orthosis or tape to interact with the foot (Kogler et al., 1999). During load transmission, the foot adapts to these conformations to produce or resist motion for the desired orthotic effect. To control the foot's longitudinal arches, the arch support mechanism through foot taping attempts to restrain the motions associated with arch depression. Several studies have been conducted for the effect of the medial wedge (Kogler et al., 1999). White non-elastic tape and kinesio tape have been widely used for athletic trainer to re-build the medial longitudinal arch and to relieve the tension of plantar fascia. It is so called anti-pronation tape since this taping technique can resist the tendency of foot pronation and increase the medial longitudinal arch height. From a clinical perspective, it is important to know how efficient the tapes are in supporting the foot's longitudinal arches for the athletes. However, little research have been documented the effect of these two anti-pronation taping techniques on arch support. Therefore, the purposes of this study were (1) to analyze the biomechanics in the subjects with different medial longitudinal arch type and (2) to investigate the effect of kinesio tape on medial longitudinal arch during jumping and landing.

Methods

Radiographic Measurements

Thirty-four females participated in the first section of data collection. Their average age was 20.3±1.7 years. Their average weight was 54.0±6.3 kg. Their average height was 160.3±5.3 cm. X-ray photos on foot were taken in three conditions for each subject. The testing conditions included non-weight bearing (supine lying), single-limb stance and double-limb stance. The dominant leg, which was used to kick the ball, was tested in this study. Navicular height, arch angle and arch index were measured and computed (Fig 1). Arch angle was defined as the angle between the line calcaneal inclination and the 1st metatarsal bone. Arch index was defined as the ratio of dorum height to the truncated foot length (Fig 2).

Motion Analysis of Vertical Jump and Drop Landing

Based on the radiographic measures, participants were divided into three groups, pronated, neutral and supinated groups. Difference between complete weight bearing and complete non-weight bearing were computed and ranked. Pronated group was defined as the difference lesser than the first quartile. Supinated group was defined as the difference greater than the third quartile. Differences greater than first quartile and less than third quartile were belonged to the neutral group. Twenty-seven subjects participated in the second section of data collection. Each subject was asked to perform vertical jump and drop landing from 30 cm height. Before data collection, 10-min warm up and several practices were performed for each subject to familiarize with the movements and equipments. In addition to bare foot, three kinesio tapes, with which the medial longitudinal arch could be elevated, were tested in this study. Kinesio tape on gastrocnemius was used to reduce the tension of gastrocnemius (Fig 3A). The tensions of tibialis anterior and intrinsic plantar muscles were increased with kinesio tape (Figs 3B & 3C). Three repetitions were tested for each condition. There were totally 24 trials (2 movements x 4 tapes x 3 repetitions) for each subject. There was at least 1-minute rest between trials.

Two Kister force plates and MA 300 EMG system were used to measure the ground reaction forces and muscle activities during vertical jump and drop landing. Bilateral vastus femoris, biceps femoris, tibialis anterior, peroneal longus, medial gastrocnemius were measured. The root mean square (RMS) values were calculated for each muscle. EMG data were normalized by the maximum voluntary contraction. Peak ground vertical reaction force, load rate, and impulses in 50 ms, 70 ms and 100 ms were calculated. Load rate was defined as the ratio of peak vertical reaction force to the time from landing to the moment at which the peak force generated. Impulse was computed with Simpson method. Based on the ground reaction force pattern, vertical jump was divided into seven phases (Fig 4) and drop landing was divided into three phases (Fig 5). Two-way ANOVA with repeated measures (4 tapes x 3 groups) was used for statistical analysis

(SPSS, V13.0). P values less than 0.05 was considered as statistical significance.

Results

Radiographic Measurements

The radiographic measures were shown in Table 1. The difference of medial longitudinal arch from non-weight bearing to single-limb stance was computed. Based on the navicular drop from complete non-weight bearing to complete weight bearing, pronated, neutral and supinated groups were defined (Table 2).

Kinetics during Vertical Jump

Kinetic data were computed in preparatory (pre-jump) phase and landing phase during vertical jump. The peak vertical reaction forces, load rates, flying times, impulses in 50, 70 and 100 ms during preparatory phase and landing phase were shown in Tables 3 and 4, respectively. There were no significant difference between different groups and different tape conditions in preparatory phase. However, supinated group (5.65%BW) showed significantly greater peak vertical ground reaction force in landing phase than neutral group (4.56%BW) ($p=0.031$), indicating the vertical ground reaction force was increased with more deformation of medial longitudinal arch in landing phase of vertical jump, but not in preparatory phase.

Kinetics during Drop Landing

The peak vertical reaction forces, load rates, impulses in 50, 70 and 100 ms during drop landing were shown in Tables 5. Significance in group factor was found in peak ground reaction force ($p=0.043$). In pairwise comparisons, peak vertical ground reaction forces in pronated group (4.96%BW) and neutral group (4.92%BW) showed significantly lesser than supinated group (6.44%BW). Load rate in supinated group (135.01%BW/sec) showed significantly greater than neutral group (87.69%BW/sec).

Significance in tape factor was found in peak ground reaction force, load rate, impulses ($p<0.05$). In pairwise comparisons, tape on plantar muscles (5.140%BW) showed significantly lesser peak vertical reaction force than tape on tibialis anterior (5.631%BW). Bare foot showed significantly greater load rate than tape conditions.

EMG activities during Vertical Jump

<u>Early-preparatory phase</u>

There was a significant difference in EMG activity of biceps femoris in early-preparatory phase between different arch groups ($p<0.05$). Supinated group (3.2%MVC) and pronated group (5.0%MVC) showed lesser EMG activity in biceps femoris than neutral group (14.1%MVC). There was a significant difference in EMG activity of biceps femoris between different tape conditions in early-preparatory phase ($p<0.05$). Bare foot (6.4%MVC) showed lesser EMG activity in biceps femoris than tape on tibialis anterior (7.7%MVC). No significance was found in other muscles.

<u>Mid-preparatory Phase</u>

There was a significant difference in EMG activity of biceps femoris between different arch groups in early-preparatory phase ($p<0.05$). Supinated group (19.3%MVC) and pronated group (21.3%MVC) showed lesser EMG activity in biceps femoris than neutral group

(29.6%MVC).

There were significant differences in EMG activities of medial gastrocnemius and tibialis anterior between different tape conditions in mid-preparatory phase ($p<0.05$). Bare foot (58.3%MVC) showed lesser EMG activity in medial gastrocnemius than tape on tibialis anterior (62.6%MVC). Bare foot (41.4%MVC) showed lesser EMG activity in tibialis anterior than tape on plantar muscles (47.4%MVC). No significance was found in other muscles.

Late-preparatory Phase

No significance was found in all muscles.

Flying Phase

There were significant differences in EMG activities of tibialis anterior between different tape conditions in flyingy phase ($p<0.05$). Bare foot (16.7%MVC) showed lesser EMG activity in tibialis anterior than tape on tibialis anterior (18.4%MVC). No significance was found in other muscles.

Early-landing phase

There was a significant difference in EMG activity of biceps femoris between different arch groups in early-landing phase ($p<0.05$). Supinated group (19.5%MVC) showed lesser EMG activity in biceps femoris than neutral group (35.9%MVC). No significance was found in other muscles.

Mid-landing Phase

No significance was found in all muscles.

Late-landing Phase

No significance was found in all muscles.

EMG activities during Drop Landing

Early-landing phase

There was a significant difference in EMG activity of biceps femoris between different arch groups in early-landing phase ($p<0.05$). Supinated group (15.8%MVC) showed lesser EMG activity in biceps femoris than neutral group (28.5%MVC). No significance was found in other muscles.

Mid-landing Phase

There was a significant difference in EMG activity of vastus lateralis between difference tape conditions in mid-landing phase ($p<0.05$). Tape on plantar muscles (88.0%MVC) showed significantly lesser EMG activity in vastus lateralis than tape on tibialis anterior (94.4%MVC). No significance was found in other muscles.

Late-landing Phase

There was a significant difference in EMG activity of vastus lateralis between difference tape conditions in late-landing phase ($p<0.05$). Bare foot (31.5%MVC) showed significantly lesser EMG activity in vastus lateralis than tape on gastrocnemius (38.3%MVC). Tibialis anterior tape (31.0%MVC) showed significantly lesser EMG activity in vastus lateralis than tape on gastrocnemius (38.3%MVC). No significance was found in other muscles.

Discussion

This study demonstrated the kinetics and EMG in the subjects with different medial longitudinal arch types during vertical jump and drop landing. The effects of kinesio on plantar muscles, tibialis anterior and gastrocnemius were investigated in this study. Based on the change in navicular height from non-weight bearing to single-limb stance, the subjects were divided into three groups. Pronated group was defined as the difference of navicular height less than first quartile while supinated group was defined as the difference of navicular height greater than third quartile. The ability to transform the arch during weight bearing would be evaluatd and the biomechanical characteristics of medial longitudinal arch during high impact movement would be more understood. How the foot arch influenced the dynamic movement or athletic performance would be identified and this information would be helpful to select the potential athletes if foot type would be associated with athletic performance.

Saltzman et al. (1995) documented that the navicular height was 3.71 cm while the measure in our study was 3.23 cm during double stance. The variables were quiet similar in both studies. Howard and Briggs (2006) reported the arch-height-index measurement system, a method of foot classification. Williams et al. (2000) reported the reliability and validity of the measurements used to characterize the medial longitudinal arch. The most reliable and valid measurements of clinically assessing arch height were the arch index, dividing the dorsum height at 50% of foot length by truncated foot length. Based on the data on 102 feet in William's study, the average arch index and the average navicular heights in 10% of weight bearing were 0.316± 0.027 and 3.97±0.56 cm, respectively. The average arch index and the average navicular height in 90% of weight bearing were 0.292±0.027 and 3.46±0.56 cm, respectively. In this study, the arch index and navicular height were 0.352±0.024 and 3.93±0.45 in non-weight bearing, respectively. The arch index and navicular height were 0.263±0.019 and 3.23±0.49 in double stance, respectively. If combining William's study and our study, it seems very reasonable that the arch index were sequentially ranked from non-weight bearing (0.352), 10% of weight bearing (0.316), 90% of weight bearing (0.292), full weight bearing (0.263).

Vicenzino et al. (2006) investigated that medial longitudinal arch posture and plantar contact area following the application of augmented low-Dye tape during walking and running. The arch increased significantly after the application of tape. Contact area was reduced in the medial and lateral rearfoot during jogging. In our study, kinesio tape on different muscles showed different characteristics on ground reaction forces during drop landing. Kinesio tape on plantar muscles showed the least vertical ground reaction force, load rate and impulses in 50, 70 and 100 ms, indicating the tape on plantar muscles substantially reduced the load and possibly reduce injury risk in lower extremity during drop landing. However, there was no significant difference between different tapes during vertical jump. It could be possibly because vertical jump is a volitional movement in which the jump height is decided by the muscle power used in lower extremity, while the drop landing is a passive motion and the height is fixed (30 cm) in this study. Thus, tape might have effect on drop landing, the passive controlled testing condition but not on vertical jump, a self-controlled active movement.

Williams et al. (2001) reported that high-arched runners reported a greater incidence of ankle injuries, bony injuries and lateral injuries. Low-arched runners exhibited more knee injuries, soft tissue injuries and medial injuries. Williams et al. (2004) reported that high-arched runners demonstrated decreased knee flexion excursion during stance and exhibited a significantly earlier onset of the vastus lateralis than the lower-arched runners. In our study, supinated group showed greater peak vertical ground reaction force during vertical jump and greater load rate during drop landing than pronated group. It was implied that supinated people might have less biomechanical benefit during high-impact exercise and prone to specific injuries. Differences in lower extremity kinetics in individuals with different foot types may have implications for new treatment strategies or preventative measures

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Table 1: Radiographic measures (mean±SD) to indicate the medial longitudinal arch

	Non-weight bearing	Double-stance	Single-stance
Navicular Height (cm)	3.934 ± 0.457	3.232 ± 0.492	3.094 ± 0.375
Arch Angle (°)	155.718 ± 5.746	157.244 ± 5.232	159.185 ± 5.372
Arch Index	0.352 ± 0.024	0.263 ± 0.019	0.304 ± 0.020

Table 2: Navicular Heights for different Groups

	Non-weight bearing (cm)	Double-stance (cm)	Single-stance (cm)	Navicular drop (cm)	Navicular drop (%)
Pronated (n=8)	3.884±0.475	3.347±0.203	3.367±0.358	0.517±0.089	12.707±533.852
Neutral (n=11)	3.948±0.387	3.222±0.479	3.061±0.312	0.886±0.170	22.419±3.446
Supinated (n=8)	4.118±0.405	3.274±0.155	2.998±0.283	1.121±0.050	26.935±4.515

Table 3: Kinetics in Preparatory Phase during Vertical Jump

		Tape Condition				
		Bare	Plantar	Tibialis Anterior	Gastrocnemius	Total
Peak Fz (%BW)	Pronated	2.12±0.11	2.13±0.11	2.09±0.12	2.13±0.15	2.11±0.12
	Neutral	2.12±0.19	2.12±0.22	2.18±0.33	2.14±0.28	2.14±0.25
	Supinated	2.26±0.46	2.21±0.37	2.22±0.39	2.16±0.21	2.21±0.35
	Total	2.16±0.28	2.15±0.24	2.16±0.30	2.14±0.22	2.15±0.26
Load Rate (%BW/sec)	Pronated	23.74±4.47	22.75±4.35	23.16±5.17	22.80±4.59	23.11±4.44
	Neutral	21.42±4.25	22.30±2.51	22.37±3.15	22.50±3.18	22.15±3.24
	Supinated	21.28±2.68	21.80±2.17	22.71±2.70	21.42±2.02	21.80±2.36
	Total	22.06±3.93	22.29±2.99	22.71±3.62	22.27±3.31	22.33±3.44

Table 4: Kinetics in Landing Phase during Vertical Jump

		Tape Condition				
		Bare	Plantar	Tibialis Anterior	Gastrocnemius	Total
Peak Fz* (%BW)	Pronated	5.48±1.32	4.91±1.25	5.68±1.54	4.98±1.09	5.26±1.29
	Neutral	4.43±1.26	4.35±0.82	4.63±0.86	4.82±0.99	4.56±0.98
	Supinated	5.39±1.68	5.90±1.33	5.34±1.22	5.96±1.07	5.65±1.31
	Total	5.02±1.44	4.98±1.26	5.15±1.24	5.21±1.12	5.09±1.26
Load Rate (%BW/sec)	Pronated	82.61±36.76	73.96±51.16	88.42±44.04	71.93±32.37	79.23±40.19
	Neutral	60.01±24.40	53.85±15.32	59.01±13.97	65.43±22.85	59.57±20.33
	Supinated	73.00±33.59	82.05±28.05	73.32±30.06	84.28±25.31	78.16±28.42
	Total	70.56±32.40	68.16±34.10	71.97±31.55	72.94±26.78	70.91±30.94
Impulse50 (%BW-sec)	Pronated	0.074±0.023	0.069±0.023	0.069±0.014	0.069±0.019	0.071±0.020
	Neutral	0.061±0.012	0.058±0.010	0.060±0.013	0.063±0.011	0.060±0.011
	Supinated	0.064±0.017	0.069±0.017	0.067±0.170	0.070±0.018	0.067±0.016
	Total	0.066±0.018	0.064±0.017	0.065±0.014	0.067±0.016	0.065±0.016
Impulse70 (%BW-sec)	Pronated	0.140±0.034	0.122±0.032	0.133±0.031	0.131±0.030	0.132±0.031
	Neutral	0.112±0.025	0.108±0.019	0.111±0.024	0.120±0.023	0.113±0.022
	Supinated	0.123±0.037	0.132±0.034	0.127±0.035	0.136±0.036	0.130±0.034
	Total	0.124±0.032	0.119±0.029	0.122±0.030	0.128±0.029	0.123±0.030
Impulse100 (%BW-sec)	Pronated	0.237±0.028	0.218±0.033	0.232±0.033	0.225±0.033	0.228±0.031
	Neutral	0.205±0.031	0.205±0.030	0.208±0.031	0.217±0.022	0.209±0.028
	Supinated	0.225±0.030	0.235±0.032	0.227±0.036	0.243±0.040	0.232±0.036
	Total	0.042± 0.022	0.218±0.033	0.221±0.033	0.227±0.032	0.221±0.033
Flying Time (sec)	Pronated	0.400±0.036	0.396±0.033	0.402±0.038	0.392±0.029	0.398±0.033
	Neutral	0.347±0.040	0.368±0.045	0.367±0.050	0.378±0.033	0.372±0-.041
	Supinated	0.386±0.027	0.391±0.031	0.392±0.027	0.392±0.036	0.390±0.029
	Total	0.385±0.036	0.383±0.038	0.385±0.042	0.386±0.032	0.385±0.037

* Significance in group factor

Table 5: Kinetics during Drop Landing

		Tape Condition				
		Bare	Plantar	Tibialis Anterior	Gastrocnemius	Total
Peak Fz* (%BW)	Pronated	4.88±1.65	4.82±1.76	5.37±1.35	4.76±1.28	4.95±1.47
	Neutral	5.07±1.22	4.61±1.22	5.14±1.62	4.85±1.38	4.92±1.34
	Supinated	6.61±1.56	5.99±1.30	6.38±1.33	6.79±2.12	6.44±1.56
	Total	5.47±1.59	5.08±1.49	5.58±1.50	5.40±1.80	5.38±1.59
Load Rate# (%BW/sec)	Pronated	99.09±62.59	92.08±54.67	109.68±45.01	89.85±47.26	97.67±50.82
	Neutral	91.06±29.09	77.32±27.71	94.65±35.21	87.75±30.95	87.69±30.48
	Supinated	148.09±72.91	117.71±35.91	136.44±59.88	137.81±71.20	135.01±59.75
	Total	110.34±58.70	93.66±41.70	111.49±47.96	103.20±53.47	104.67±50.64
Impulse50 (%BW-sec)	Pronated	0.095±0.033	0.092±0.032	0.095±0.031	0.087±0.032	0.093±0.031
	Neutral	0.093±0.020	0.085±0.019	0.091±0.019	0.090±0.016	0.090±0.018
	Supinated	0.115±0.026	0.103±0.027	0.106±0.024	0.113±0.047	0.110±0.031
	Total	0.100±0.027	0.092±0.026	0.097±0.024	0.096±0.033	0.096±0.027
Impulse70 (%BW-sec)	Pronated	0.158±0.043	0.151±0.039	0.159±0.025	0.152±0.039	0.155±0.036
	Neutral	0.163±0.030	0.149±0.031	0.161±0.030	0.157±0.029	0.158±0.030
	Supinated	0.186±0.031	0.176±0.030	0.178±0.025	0.182±0.053	0.181±0.035
	Total	0.168±0.035	0.158±0.034	0.166±0.027	0.163±0.041	0.164±0.034
Impulse100 (%BW-sec)	Pronated	0.239±0.044	0.232±0.039	0.237±0.022	0.234±0.041	0.236±0.036
	Neutral	0.244±0.030	0.234±0.032	0.242±0.033	0.238±0.033	0.240±0.031
	Supinated	0.267±0.034	0.260±0.030	0.262±0.024	0.263±0.044	0.263±0.032
	Total	0.249±0.036	0.241±0.035	0.246±0.029	0.244±0.039	0.245±0.035

* Significance in group factor; # Significance in tape factor

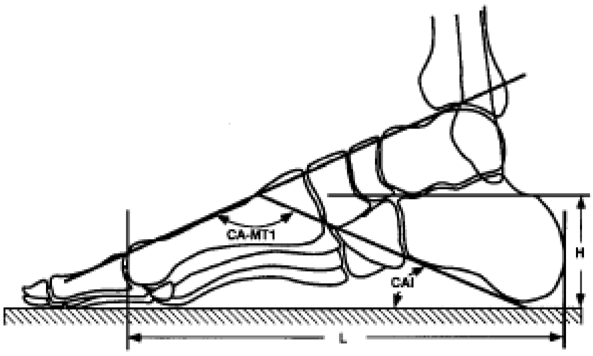


Figure 1: H=navicular height; CA-MT1=arch angle:

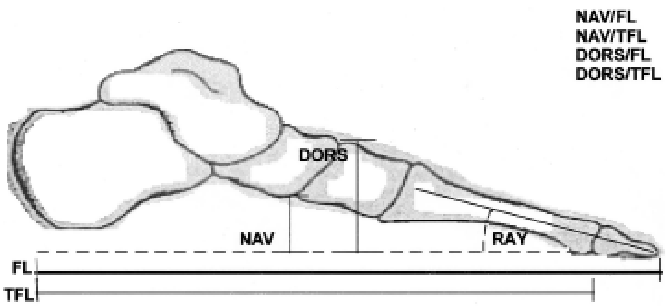


Figure 2: Arch index =DORS/TFL; DORS=dorsum height at 50% of foot length; TFL=truncated foot length.

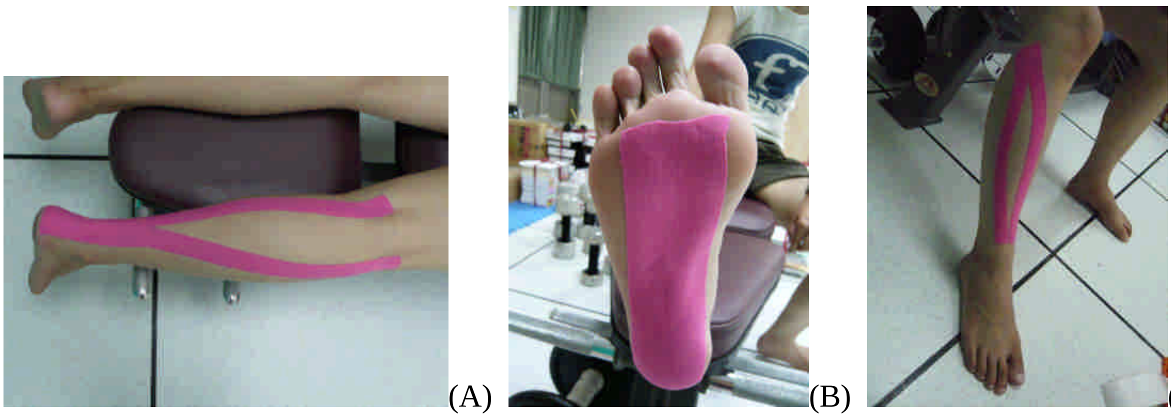

(A) (B) (C)

Figure 3: Kinesio tapes for gastrocnemius (A), intrinsic plantar muscles (B) and tibialis anterior (C).

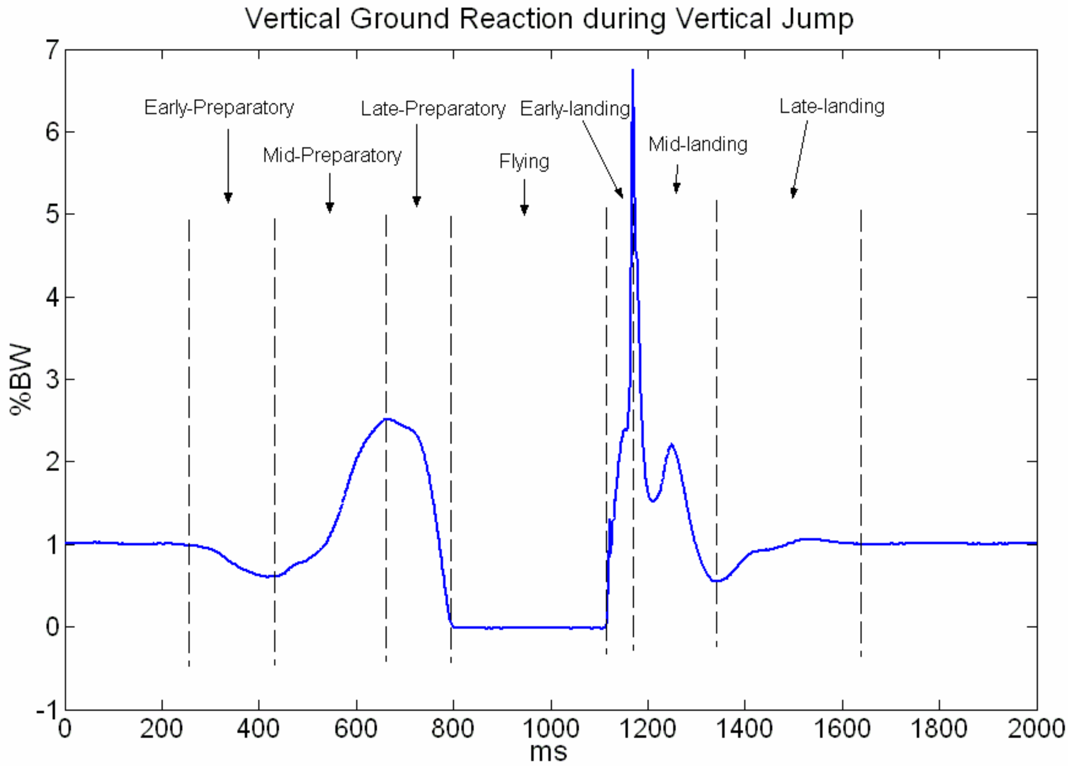


Figure 4: Seven phases during vertical jump

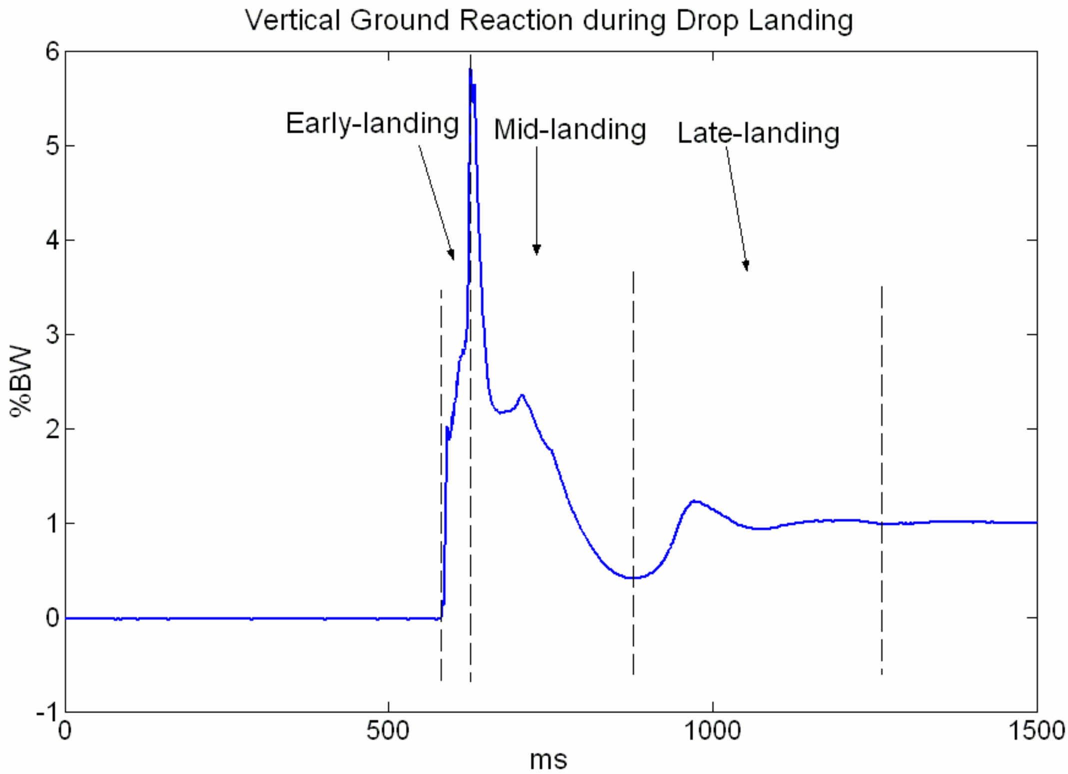


Figure 5: Three phases during drop landing

計畫成果自評

本研究計畫主要探討足部內側縱向足弓對於跳躍運動時的生物力學影響，研究分為二個階段，第一階段為收集 34 位女性受試者的足部 X 光影像，分別在未承重、雙腳站立與單腳站立時測量，依舟狀骨高度的變化量作為分組的依據，由完全不承重至完全承重，根據舟狀骨高度變化量排序，落於第一四分位數之前的為旋前組(pronated group)，表示足弓變化較小，落於第三四分位數之後的則為旋後組(supinated group)，表示足弓變化較大，而居於第一四分位數之後且第三四分位數之前者，則屬於中間組(neutral group)，此種分類方法，可以考慮在完全不承重與承重之間的足弓高度變化量之影響，也就是壓迫足弓的可變形量，目前於文獻之中，並沒有發現這樣的分類方式，而這樣的足弓考慮模式，亦可成為一種新的足弓評估方法。

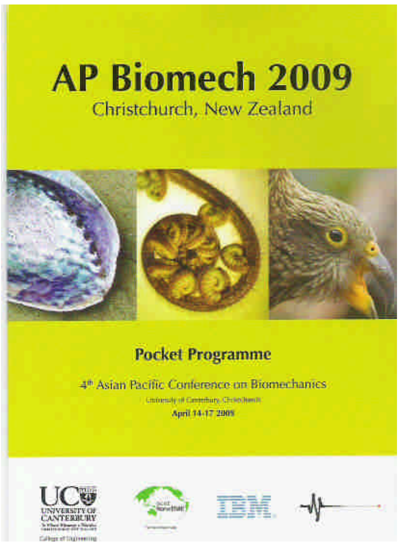
由於足弓的功能被認為有吸收衝擊動作震盪的效益，因此，在研究的第二階段，依照分組模式，旋前組與旋後組分別找了 8 位受試者，而中間組則收集了 11 位受試者，請他們作出自主垂直跳躍、與直接落地動作，分別比較這三組在衝擊性運動的不同，嘗試發現足功對於衝擊的效益。結果發現，旋後組在垂直跳躍的落地期，有較大的垂直反作用力出現。而在直接落地動作中，旋前組與中間組有較小的垂直反作用力與負荷速率出現。在肌電訊號部分，大部分的肌肉收縮活動性皆無明顯分別，只有在垂直跳躍的準備期時，中間組的股二頭肌出現較強的肌電訊號強度。除了探討足弓高低的影響性之外，本研究也探討肌內效貼布在衝擊性運動中，對於不同足弓的影響，將肌內效貼布貼在腓腸肌、脛前肌與腳掌內在肌上，結果發現，貼肌內效貼布在腳掌內在肌時，在直接落地的動作中，會出現較小的垂直反作用力，完全沒有貼的情況下，有較大的負荷速率出現。

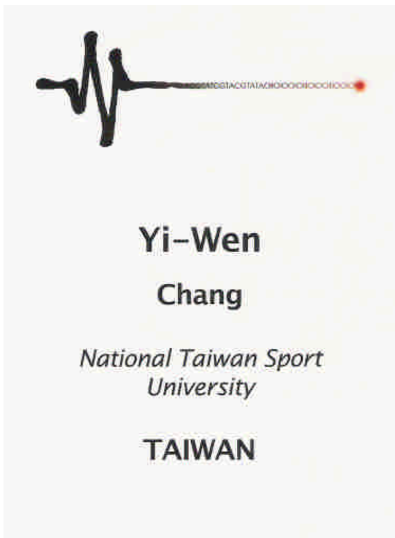
本研究的實驗設計，主要探討不同的足弓變化量對於跳躍與落地運動的影響，並且加入肌內效貼布的介入，結果發現不同足弓變化的族群，確實有不同的動力學表現，顯示足弓高低的變化，會改變對下肢的衝擊。另外，肌內效貼布在臨床上有相當多的使用經驗，但於實証醫學上，尚沒有很多的證據支持其治療效果。經由本研究結果的發現，可以提供臨床運動傷害的研究資料，並可作為治療介入的參考依據。在不久的未來，作者將會把資料整理更完整，並作更詳盡的分析與討論，把成果投稿呈現於國際運動醫學期刊上。

出國報告書

參加 2009 年第四屆亞太生物力學學術研討會出國報告書

The 4th Asian Pacific Conference on Biomechanics





服務機關：國立台灣體育大學(臺中)運動健康科學學系

出 國 人

職　　稱：助理教授

姓　　名：張怡雯

出國地區：Christchurch, New Zealand

出國期間：Apr 11, 2009 – Apr 18, 2009

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目　　錄

一、前言：會議解說

每二年舉辦一次的亞太生物力學界盛事—2009 年第 4 屆生物力學學術研討會（The 4th Asian Pacific Conference on Biomechanics），今年假紐西蘭基督城坎特貝理大學（University of Canterbury, Christchurch, New Zealand）舉辦。

第一屆亞太生物力學年會，自 2004 年於日本大阪大學舉辦以來，2005 年在臺灣台北的國立台灣大學舉辦第二屆年會，第三屆年會在 2007 年於日本東京大學舉辦，第四屆生物力學學術研討會，今年則假紐西蘭基督城坎特貝理大學舉辦。按照以往會議議程，此次會議共計四天, 於 2009 年 4 月 14 日展開序幕而於 4 月 18 日結束，此次會議規模龐大，參與會議代表包含來自澳洲、香港、日本、伊朗、南韓、馬來西亞、新加坡、臺灣、英國與美國，加上地主國紐西蘭，共計數百名來自亞太地區與世界各國學者參與盛會，發表將近 200 篇生物力學相關論著與研究論文發表，堪稱國際生物力學上最大盛會之一。

圖一：大會會場大廳門口

二、舉辦城市簡介

2009 年亞太生物力學學術研討會，今年假紐西蘭基督城坎特貝理大學舉辦。由於紐西

蘭地大人稀，就算身處於都市之中，也不會像在臺灣的都市那樣的感到擁擠，就算是在大城市的市中心，也幾乎不會有塞車的現象出現。基督城為紐西蘭南島的最大城市，人口數約為36萬人，城市內到處種滿了各色花草與樹木，因此，素有「花園城市」的美名，也被許多旅人描述為「在英格蘭以外的地區，最像英格蘭的城市」(The most English city outside England)。同時，基督城還有一條蜿蜒穿越整個城市的雅芳河（Avon river)，其中有許多石墩橋橫跨其上，更是讓整個城市妝點的美輪美奐。四月對於紐西蘭而言，已經是秋季了，漫步於雅芳河邊，地面上佈滿了紅黃交錯的落葉，落英繽紛，偶爾可見整株火紅的的楓葉，真是美麗極了。秋天的紐西蘭南島溫度其實已經相當近似臺灣寒冬的溫度，由於秋意甚濃，來自於熱帶與亞熱帶國家的學者們，走在戶外，較厚的大衣外套已都不離身，當晚上的冷風吹過，的確是涼徹心扉，令人不今微微發抖起來。

圖二：花園城市的基督城

由基督城橫跨越過坎特貝理平原（Canterbury Plains)，就是貫穿整個南島的南阿爾卑斯山脈，其中有許多符合國際規格的滑雪場。紐西蘭人相當喜好戶外活動，坎特貝理地區常見的戶外活動，包含滑雪、賞鯨、動力汽艇、登山、風帆、賞企鵝、高空彈跳、熱氣球、四

輪驅動車等，有一些活動具有相當程度的冒險刺激。

基督城在具有大自然的純樸樣貌的同時，也擁有各種高科技的設施，尤其是公共交通設備，相當的先進與便利，在市中心約有 50 幾條的公車路線，往各個不同方向的市郊或附近的小鄉鎮行駛，同時每輛公車皆有時刻表，可以先看好時間再去搭車，公車到達相當的準點，真是令人佩服。由於在基督城住宿的旅館位於市中心，而研討會開會的坎特貝理大學位於較北邊的郊區，因此，每天早上須由旅館出門，搭公車到坎特貝理大學參加研討會，單程票為紐元 2.8 元，相當於台幣約 50 元，相較之下，臺灣的公車價顯得較平價些。

圖三：坎特貝理大學校園一隅

三、舉辦機構簡介

這次的亞太生物力學研討會，主要由坎特貝理大學（University of Canterbury）主辦。坎特貝理大學自 1873 年創校以來，至今已有 130 年以上的歷史，是紐西蘭南島最大的一所大學，總共包括 6 個學院（藝術學院、工程學院、教育學院、商業與經濟學院、理學院、法學院）、28 個學術單位、內含 40 個以上之系所，並有許多的研究中心（如生物醫學研究中心、

健康科學中心、社會科學研究中心、分子生物研究中心、大氣科學研究中心等)，現今學生數量約為 12000 位，每年大約有 3000 位學生畢業，規模非常龐大，學術研究風氣興盛，為紐西蘭研究型大學的領導先驅。

坎特貝理大學佔地非常廣大遼闊，占地 76 公頃以上，在 1975 年由原本位於市中心較小的舊校區，牽校至目前的位置，位於基督城的北邊市郊，離市中心約 7 公里的距離，學校內的建築物大都為英式牛津風格，隱含在一大片的綠地與樹木之中，相當典雅漂亮。觀察整個校園，發現與臺灣的學校很不一樣的地方在於，坎特貝理大學校園內幾乎看不到任何的廣告招牌或宣導布條，就算是國際研討會在校內舉辦，也只有一張小小的 A4 大小紙張所印出會議名稱，置於會議廳的門口，指引各國學者會議開會的位置所在。然而，由於此指示牌實在太小，且置放於地上，因此第一天尋找會議廳時，還是稍微迷路了一下。

圖三：2009 年亞太生物力學學術研討會的指示看板

四、會議特色

此次研討會極具規模，整個會議共持續四天，除了第一天為註冊報到暨歡迎酒會之外，

其他各天都根據不同的專題進行口頭發表（Oral presentation），海報發表（Posters），以及不同領域的主要專題報告（Plenary lectures）。 由於發表的不同論文主題多，有 4 個演講廳同時舉行口頭論文發表，因此參加者必須依大會手冊及論文摘要，選擇自己有興趣的題目去聽論文發表。此外，大會於每天中午於會場外，皆有安排豐盛的午餐，提供參加研討會的學者們享用，並進一步領略一下紐西蘭道地的美食。

圖四：大會提供中午豐盛的午餐

在純學術活動之餘，大會亦舉辦一些文化與社交活動，例如開幕當天的歡迎酒會，另外在星期四的下午，帶領各國學者參加「達馬其傳統文化村之旅」(Tamaki Heritage Village Excursion)，達馬其傳統文化村位於基督城東邊市郊不遠處的哈里福特公園內（Hereford park)，利用說故事的表演方式，介紹英國人在紐西蘭移民的歷史，與原住民毛利人之間的文化衝突與歷史戰爭和解過程，並有一大群演員作即時的表演，文化村之內有各式的場景佈置及音效，相當的逼真寫實，也讓人感受到紐西蘭文化的震撼，確實也讓各國學者對於紐西蘭的文化傳統與歷史背景，有了更深一層的認識。

圖五：各國學者盡情歡度「達馬其文化村之旅」(Tamaki Heritage Village Excursion）

五、學習收穫與心得感想

經過這幾天密集的聽講還有與其他國家學者的共同討論，真是受益良多。 畢竟很難得才有機會飛到不同的國家參與國際性學術會議，與這麼多從事生物力學研究的人才共聚一堂，從這些天的學習與腦力激盪所得的經驗之下，對於生物力學的趨勢發展，有些許的收穫與心得感想。

本次會議研究主題包羅萬象，屬於生物力學應用於各方面的研究探討，其中包含以下各主題：心血管生物力學（Cardiovascular Biomechanics）、骨骼肌肉生物力學（Musculoskeletal Biomechanics）、骨頭韌帶生物力學（Bone and Ligament Biomechanics）、骨科復健生物力學（Orthopaedic & Rehabilitation Biomechanics）、心肺呼吸生物力學（Cardiopulmonary & Respiratory Biomechanics）、齒科生物力學（Dental Biomechanics）、奈米生物力學（Micro and Nano Biomechanics）、電腦生理模擬（Computational Physiological Modelling）、人工器官與移植（Artifical Organs and Implants）、與運動生物力學（Sports Biomechanics）。這些主題所呈現的研究結果能夠對於醫學各領域中產生直接的貢獻，並可以部分應用於運動員的表現上，同

時也有不少關於組織工程的研究發表，另一部分為生物力學之研究分析方法的發表，這包括了電腦模擬動畫、類神經網路、最佳化方法、有限元素法等，確實使人收穫良多、受益匪淺。

圖六：在會場中遇到來自臺灣的不同學校之學者

來自澳洲昆士蘭理工大學醫學工程研究所 Pearcy 教授，在 4 月 16 日的主題演說之中，介紹了「模擬對於生物力學的價值」(The Value of Modelling to Biomechanics)，Pearcy 教授再生物力學界從事研究工作已有超過 30 年以上的時間，發表超過 180 篇以上的專業學術文章，並於 1992 與 2001 年皆榮獲澳洲脊椎醫學研究學會的學術研究獎，是一位非常資深且傑出的生物力學研究學者。在這次的演說之中，他提到機械模擬的方法如何應用於人體的行為或動作上，了解這些力學模擬的方式，才能有效的應用於傷害與疾病的預防和醫學治療之上。同時，模擬的原理與技術，還能改變外在的環境與身體參數，用以預測身體組織對於任何環境或身體變化的組織改變。有限元素法（Finite element）經常被使用於模擬硬組織與軟組織，雖然此方法有些許限制，但其預測的功能非常強大，因此，在健康照護與健康促進上的應用，功不可沒。例如，在骨折的固定上，可以模擬不同形狀或材料之固定板，探討骨頭固定之功

效與最佳化應用；使用義肢將如何對人體其他的骨頭產生任何的改變；骨質疏鬆如何影響到脊椎的強度等，這些與人體結構息息相關的參數變化，不需要真的等到病人產生傷害後才事後調查研究，可以預先由人體模擬的方式，就可以知道傷害對於人體的力學影響。

圖七：筆者與所發表的海報

在研討會 4 月 16 日的早上，有一個場次的主題為運動生物力學，其中，來自於國立新加坡大學的 James Goh 教授所帶領的生物力學研究團隊，進行的一個關於使用運動傷害護具的力學實驗，相當有趣且實用，簡述如下。前十字韌帶損傷對於跳躍衝擊運動而言，是一個非常常見的運動傷害，然而，對於使用前十字韌帶護具的效益優劣與否，一直有各種不同的評比與討論，因此，這個實驗探討膝關節護具對於跳躍落地的力學影響，並比較二種護具（Ossur ligament brace 與 inhouse-built knee protective device）在減少脛骨前移與軸向旋轉的差異，利用力板與動作分析系統，收集 5 位運動員在單腳落地時之生物力學資料，結果發現，只有在 60 cm 高處之單腳落下的資料有顯著差異（$p<0.05$），當未穿戴膝護具時，落地時有較大的地面衝擊力，而由高處落地時，穿戴保護型護具，顯示有較小的脛骨前移，穿戴 Ossur

護具，顯示有較大的脛骨旋轉。因此，使用保護型護具，確實可以減少造成前十字韌帶損傷的危險因子之影響性。根據這樣的研究成果，運動員適時的穿戴適當的膝關節護具，的確可以緩解前十字韌帶的負荷，進而減少韌帶受傷的機率。

六、結語

運動生物力學為生物力學領域中的一個研究範疇，除了傳統生物力學的研究之外，近年來對於運動生物力學的研究亦日趨蓬勃，由於人體的運動表現是相當複雜，而各個系統相互分工與統整，才能使運動表現完美成熟。由於自己本身的研究屬於運動生物力學領域，希望藉由參加此種國際性會議，與各國學者相互交流與對談，俾使生物力學領域能更加茁壯，相互激盪出更理想的主題研究與方法，最終的研究成果，能實際應用於體育運動之推廣、運動傷害之防護、與運動表現之促進上，造福所有的競技運動員與一般愛好運動者身上。

此次會議規模龐大，議題包羅萬象，會議本身提供了一個很好的學習、拓展視野與文化交流的機會，學者彼此之間的互動也非常的可貴，這次參與不但遇到很多台灣的研究學者，也有機會和許多其他各國的學者相互交流與討論，獲得了許多寶貴的建議，更讓自己在專業領域之中，增添了不少新知。不論是對個人的視野，或研究工作的充實，均有耳目一新的領悟與收穫。

附件一：會議議程

WEDNESDAY 15 APRIL 2009				
8.00am – 8.30am	**Conference Registration** Central Lecture Block			
8.30am - 9.00am	**Opening Address** Central Lecture Theatre C1	**Dr Rod Carr** *Vice Chancellor, University of Canterbury*		
9.00am - 10.30am	**Oral Presentation Session 1**			
	Commerce 009 **Cardiovascular Mechanics**	**Commerce 011** **Musculo-Skeletal Biomechanics**	**Commerce 012** **Bone and Ligament**	**Commerce 013** **Orthopaedic & Rehabilitation Biomechanics**
9.00am - 9.15am	Shimpei Kohri *Development of a miniaturized fiber-optic LDV sensor for measurement of local and instantaneous blood velocity in pulsatile flow*	Jia-Jin Jason Chen *Biomechanical and Electrophysiological Analysis of Repetitive Transcranial Magnetic Stimulation Effect on Parkinsonian Rats*	Takako Osawa *Biomechanical evaluation of degenerated articular cartilage based on viscoelastic anisotropic inhomogeneous model considering tissue microstructure*	Behrooz Sepehri *Analyzing Visco-elastic Indices of Rigidity in Parkinson's Disease*
9.15am - 9.30am		Katja Onerhofer *Comparison of two modeling techniques in predicting muscle-tendon lengths during walking*	Hirohito Kobayashi *A new technique for evaluating the axial properties of stretched ligament/tendon*	Ming-Shaung Ju *Control of Active Ankle Muscle Torque by using Electromyography-based Model for Robot-Assisted Rehabilitation of Stroke Patients*
9.30am - 9.45am	Muneichi Shibata *Atrial Vortex Measurement by Magnetic Resonance Imaging*	Sota Yamamoto *Effects of Torso Posture on the Risk of Hip Fracture*	Shuichi Wakayama *AE Monitoring of Damage Accumulation during Fatigue Fracture of Cortical Bone*	Caroline Grant *Creation of a validated 3D finite-element model of an ovine tibia*
9.45am - 10.00am		Allan Bruce Carmen *Expanded marker sets in 3D Motion Analysis*	Bijay Giri *Characterization of mineral crystallites deformation under tensile loading*	Shojiro George Terashima *Development of Mouthpiece Type Remote Controller for Disability Persons ---3rd report---*
10.00am - 10.15am	ChangHo Yu *Study on a Catheter Movement with Poly (vinyl alcohol) Hydrogel for the Development of an In-Vitro Tracking System*	Seonhong Hwang *Gait Initiation and Termination in Patient with Hemiplegia*	Masao Tanaka *Computational study on effect of osteocyte apoptosis and targeted remodeling in trabecular bone remodelling*	Jongsang Son *An algorithm for estimating muscle force from joint angles*
10.15am - 10.30am		Yongwoo Yi *Linear motion perception and Lower limb somatosensation*	Ei Yamamoto *Effects of non-destructive overloading on the microstructure and mechanical properties of rabbit patellar tendons*	

WEDNESDAY 15 APRIL 2009 (continued)

10.30am - 11.00am	**Morning Tea** Central Lecture Block Foyer			
11.00am - 12.00pm	**Plenary Session 1** Central Lecture Theatre C1	**Professor Tim Secomb** *The mechanics of red blood cell motion in microvessels*		
12.00pm - 2.00pm	**Lunch and Poster Session** Central Lecture Block			
2.00pm - 3.30pm	**Oral Presentation Session 2**			
	Commerce 009 **Cardiopulmonary & Respiratory Mechanics**	**Commerce 011** **Dental Biomechanics**	**Commerce 012** **Micro and Nano Biomechanics**	**Commerce 013** **Computational Physiological Modelling**
2.00pm - 2.15pm	Toshihiro Sera *Airflow simulation in the pulmonary acinar model imaged by synchrotron micro-CT*	Hun Park *Comparison of Surface Roughness in Various Combinations of Orthodontic Archwires/ Brackets Interface by AFM*	Kenkichi Ohba *Estimation of the capability of shape recovery of each erythrocyte by using a micro-channel technique*	Nicole Kleinstreuer *A Mathematical Model of Renal Autoregulation in the Rat*
2.15pm - 2.30pm	Gijs Ijpma *Airway Smooth Muscle dynamics*	Keisuke Mamada *Measurement of Dynamic Vscoelasticities and Sensory Evaluations of Poly (Vinyl Alcohol) Hydrogel for Development of Oral Mucosa Model*		Gregory Sheard *Alteration in wall shear stress caused by non-axisymmetric flow in a fusiform abdominal aortic aneurysm*
2.30pm - 2.45pm		Keyoung Jin Chun *The Mechanical Behaviors of the Mandibular First Premolar*	Ashvin Thambyah *A microstructural analysis of load distribution in compressed cartilage*	Taiji Adachi *Average Turnover Rate of Actin Filament Accelerated by Severing: Coarse-grained Modeling and Simulation*
2.45pm - 3.00pm	Caroline Grant *Gravity dependant ventilation/perfusion ratios in healthy adults measured with Electrical Impedance Tomography*	John Middleton *Innovations in Facial Imaging, Muscle Movement and Expression*	Yoshihiro Ujihara *Effect of passive reorientation of actin filaments on the whole cell stiffness in a tensile test*	Choengryul Choi *Dynamics of Blood Cells in a Simple Shear Flow*
3.00pm - 3.15pm		Warwick Duncan *Micro-computerised tomography for the measurement of bone mineral density around titanium dental implants*	Kazuaki Nagayama *Effects of cyclic stretch waveform and cell density on the cyclic stretch-induced stress fiber reorientation in osteoblast-like cells*	Jennifer Siggers *Flow in the vitreous humour of the eye induced by saccadic eyeball motion*

WEDNESDAY 15 APRIL 2009 (continued)

3.30pm - 4.00pm	**Afternoon Tea** Central Lecture Block Foyer				
4.00pm - 5.30pm	**Oral Presentation Session 3**				
	Commerce 009 **Artificial Organs and Implants**	**Commerce 011** **Cardiovascular Mechanics 2**	**Commerce 012** **Musculo-Skeletal Biomechanics 2**	**Commerce 013** **Bone and Ligament 2**	**Commerce 101** **Cardiopulmonary & Respiratory Mechanics 2**
4.00pm - 4.15pm	Kazuo Takakuda *ACL Reconstruction Using Chitin Coated Fabrics in a Rabbit Model*	Ashis Mookerjee *Detection of central arterial diseases using aortic impedance*	Yu-Chih Lin *Human Recognition Based on Foot Pressure Patterns during Gait*	Kozaburo Hayashi *Effects of Restressing after Stress Shielding on Mechanical Properties of Regenerated and Residual Tissues in Rabbit Patellar Tendon after Removal of Central One-Third*	Jacqui Jauncey-Cooke *Lung de-recruitment and re-recruitment following suction of the endotracheal tube in paediatrics*
4.15pm - 4.30pm	Yukiya Yamada *AE Monitoring of Microdamage during Compression Test of Ceramic Femoral Head*	Patrick Geoghegan *Experimental investigation of flow in compliant tubes to validate numerical models of aneurysms*	Gongfa Chen *Influences of Blood Supply on Bone Fracture Healing - Numerical Investigations*	Masao Tanaka *Microscopic evaluation of mechanical and material properties in rat cortical bone by nanoindentation and Fourier-transform infrared microspectroscopy*	Callum Spence *Upper Airway Stereoscopic Particle Image Velocimetry Measurements with High-Flow Nasal Cannula*
4.30pm - 4.45pm		Mushtak Al-Atabi *Experimental Study of the Flow through a Two Dimensional Mitral Valve Model*	Marcus Pandy *Subject-specific Evaluation of Patellofemoral Joint Biomechanics*	Samuel Peter Veres *Morphological Signatures of Flexion Related Disc Herniation*	Caroline Grant *Ventilation inhomogeneity during quiet breathing*
4.45pm - 5.00pm	Yi-Hsuan Peng *Effect of different velocity and shoulder joint angle in activation of shoulder muscle*	Kiyoshi Kumahata *Fluid-Structure Interaction Simulation in Heart driven by Myocardium Cell Behavior based on Eulerian Frame*	Sanjay Mishra *Investigation of the mechanical environment in normal and injured equine superficial digital flexor tendons by FE Analysis*		Prasika Reddy *Viscoelastic and Surface Tension Models of the Neonatal Respiratory System*
5.00pm - 5.15pm	Kanchana Rathnayaka *Quantification of the Accuracy of MRI Generated 3D Models of Long Bones*	Koji Fumoto *Study on flow and heat transfer characteristics of pharyngeal cooling cuff for brain hypothermia treatment*	Sung-Jae Hwang *Joint movements and muscle length during sit-to-stand at various sitting heights in the Korean elderly daily life*		
5.15pm - 5.30pm		Harvey Ho *A Haemodynamics Study for Intracranial Aneurysm Rupture*	Yasuaki Ohtaki *Kinematic Analysis of Patellar Tendon Reflex Responses in Healthy Subjects Utilizing Six-axis Inertial Sensor*		

THURSDAY 16 APRIL 2009

8.00am – 8.30am	**Conference Registration** Central Lecture Block			
8.30am - 10.30am	**Oral Presentation Session 4**			
	Commerce 009 **Additional Session**	**Commerce 011** **Cardiovascular Mechanics 3**	**Commerce 012** **Sports and Impact Biomechanics**	**Commerce 013** **Cellular and Molecular Mechanics Global COE Session** **Chair: Kazuhiko Yanai**
8.30am - 8.45am	Jaw-Lin Wang *The Rheological Properties of Intervertebral Disc Change with Creep Magnitude and Creep History*	Vickie Shim *Knee contact forces during gait: Part 2 – Finite Element analysis of tibio-femoral articulation*	Chen Hua Yeow *ACL injury prevention during landing requires substantial inhibition of anteriortibial translation and axial tibial rotation using effective bracing*	Koki Oya *Mechanical cyclic stretch stimulates matrix metalloproteinases production from macrophages*
8.45am - 9.00am	Bummo Ahn *Minimally Invasive Motorized Indenter for Measurement and Modeling of Soft Tissue Behavior*	Futoshi Mori *Influence of Transformation by Stent Expansion on Blood Flow in Carotid Artery*	Keane Wheeler *Agility Skill Execution in Rugby Union*	Tsubasa Matsui *In vitro measurement of viscoelastic properties of actin bundles using micro-tensile tester with visual feedback control*
9.00am - 9.15am		Shunichi Kobayashi *Influence of Cyclic Change of Distal Resistance on Pulsatile Flow and Deformation in Coronary Stenosis Model*	Yi-Jung Tsai *Effect of Gender on Lower Extremity Biomechanics during Shuttle Running*	Shun Kumano *Significant increase of active prestin molecules by single amino acid replacement*
9.15am - 9.30am		Tong-Miin Liou *Intra-aneurysmal Hemodynamics for Curved Vessel Installed with Wallstent*	Yusuke Miyazaki *Deformation measurement of a brain part in head physical model during rotational impact*	Toshihiro Omori *Effect of the membrane bending stiffness on the deformation of a red blood cell*
9.30am - 9.45am		Hai Lan *Mechanical Factors in Non-invasive Blood Pressure Measurements*	Liu Yin-Yin *The Acute Effect of Whole Body Vibration Training in Foot Pressure Distribution in Static Standing of the Stroke Patient*	Noriaki Matsuki *Low voltage pulses can induce apoptosis*
9.45am - 10.00am			Lan-Yuen Guo *Reliability and Validity of Ankle Proprioceptive Measurements: Using a Novel Designed Two-axis Device*	Natsuko Chiba *Identification of a new target of cancer therapy by a proteomic study*
10.30am - 11.00am	**Morning Tea** Central Lecture Block Foyer			
11.00am - 12.00pm	**Plenary Session 2** Central Lecture Theatre C1	**Professor Mark J. Pearcy** *The Value of Modelling to Biomechanics*		
12.00pm - 1.15pm	**Lunch** Central Lecture Block Foyer			
1.15pm - 4.30pm	Tamaki Heritage Village Excursion			
7.30pm - 11.00pm	Conference Gala Dinner, Hotel Grand Chancellor			

FRIDAY 17 APRIL

8.00am – 9.00am	**Conference Registration** Central Lecture Block			
9.00am - 10.30am	**Oral Presentation Session 5**			
	Commerce 009 **Computational Physiological Modelling 2**	**Commerce 011** **Micro and Nano Biomechanics 2**	**Commerce 012** **Cardiovascular Mechanics 4**	**Commerce 013** **Imaging and Measurement Integration Global COE Session** **Chair: Tetsu Tanaka**
8.30am - 8.45am	Sheikh Rashed Buksh *Study of Flea Jumping Mechanism for Biomimic Robot Design*	Shinji Matsushita *Evaluation of extensional stiffness of a single actin filament by molecular dynamics simulation*	Marie Oshima *Numerical simulation of blood flow and mass transport in atherosclerotic artery*	Kentaro Imagawa *Formulation for Eigenvalue Analysis of Error Dynamics of Measurement Integrated Simulation*
8.45am - 9.00am	Xiaobing Chen *Numerical Simulation of Septal Deviation Effects in Nasal Flow*	Susumu Kudo *Intercellular Ca2+ communication in cultured endothelial cells in response to caged compounds*	Hiroyuki Kosukegawa *Study on the Development of Blood Vessel Biomodeling with Realistic Mechanical Properties By Using Poly (vinyl alcohol) Hydrogel*	Kenichi Funamoto *Effect of Aliasing on Ultrasonic-Measurement-Integrated Simulation of Three-Dimensional Unsteady Blood Flow*
9.00am - 9.15am		Takeo Matsumoto *Microscopic heterogeneity in the mechanical environment of porcine thoracic aorta*	Nicolas Buchmann *Three-dimensional In-Vitro Measurements of Carotid Artery Haemodynamics*	Takahito Miki *Numerical Simulation of Inpiratory and Expiratory Pulmonary Airflow using a Patient-specific Model*
9.15am - 9.30am	Juliana Hee-Kyung Kim *The Effects of Skeletal Muscle Fibre Distributions on Action Potential Distributions*	Yeongjin Kim *Nanomechanical analysis of AFM probing on living cells with cytoskeleton disassembly*	Hugh Blackburn *Transient growth in stenotic flow with a physiologically realistic waveform*	Hiroshi Kanai *Propagation of Electric Excitation and Vibrations in the Human Heart*
9.30am - 9.45am	Yoshitaka Nakanishi *Box Training System for Arthroscopic Surgery*	Teruo Murakami *Roles of adsorbed film and gel layer in hydration lubrication in natural synovial joints*		Hideyuki Hasegawa *High Frame Rate Ultrasonic Imaging of Artery-Wall Strain and Blood Flow*
9.45am - 10.00am				Kazuhiko Yanai *Molecular Imaging and its Application to Drug Development*
10.30am - 11.00am	**Morning Tea** Central Lecture Block Foyer			
11.00am - 12.00pm	**Plenary Session 3** Central Lecture Theatre C1	**Professor Shigeo Wada** *Spring network modeling for multiscale mechanics from cells to organs*		
12.00pm - 1.00pm	**Lunch** Central Lecture Block Foyer			

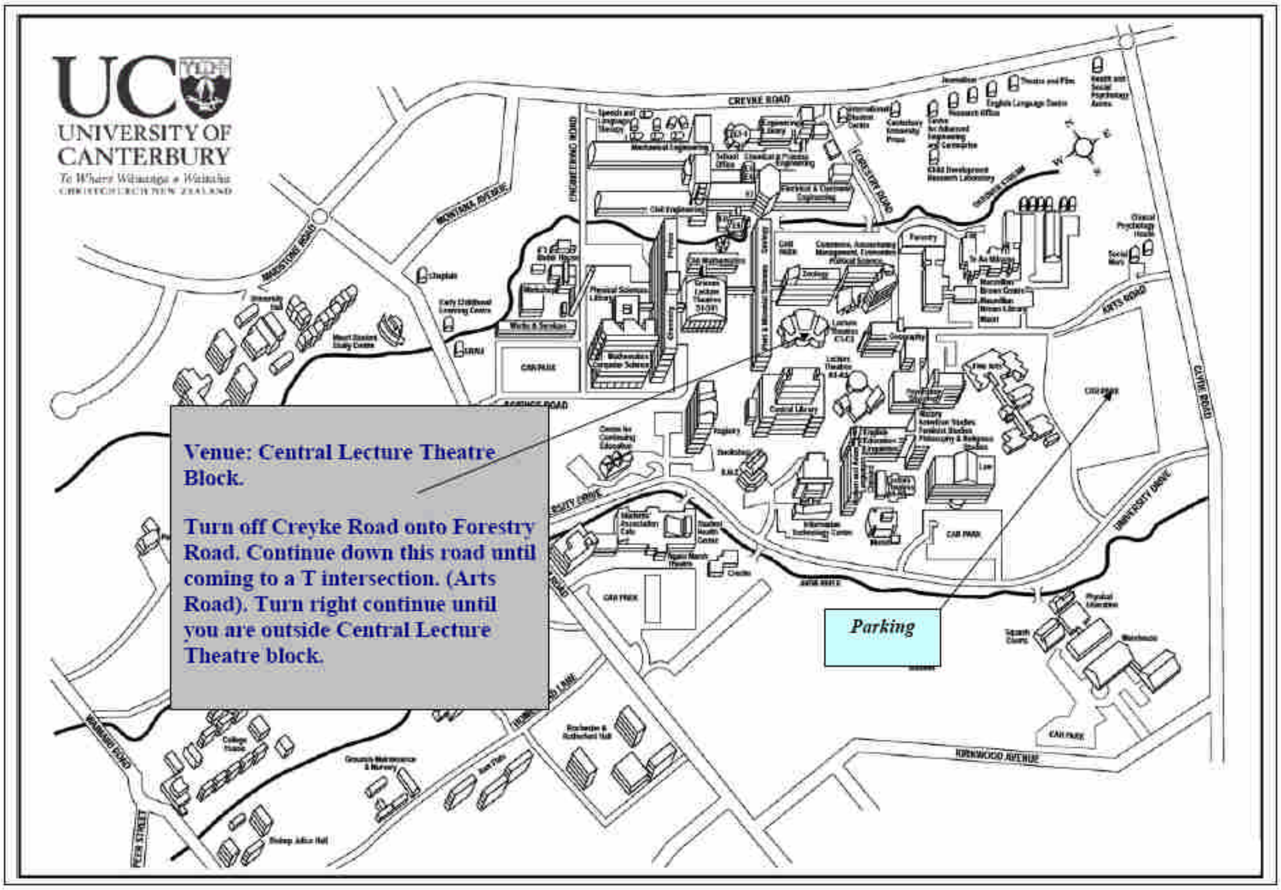
FRIDAY 17 APRIL (continued)

1.00pm - 2.00pm	**Plenary Session 4** Central Lecture Theatre C1	**Professor James Goh** *Functional biomimetic silk-based scaffold for tissue engineering application*		
2.00pm - 3.30pm	**Oral Presentation Session 6** **Commerce 009** **Sports and Impact Biomechanics 2**	**Commerce 011** **Orthopaedic & Rehabilitation Biomechanics 2**	**Commerce 012** **Medical Devices from Nano to Macro Scales** **Global COE Session** **Chair: Hiroshi Fukuda**	**Commerce 013** **Bone and Ligament 3**
2.00pm - 2.15pm	Bing-Shiang Yang *Gait Modulation following Floor Surface Change*	Keiji Imado *Development of simple goniometer for hip joint utilizing universal joint*	Matsuhiko Nishizawa *Electrochemistry-Based Biointerface Engineering*	Zhongqing Su *Quantitative Evaluation of Coupling Effect of Soft Tissues on Propagation of Anti-symmetric Lamb Wave Mode in Cortical Bones*
2.15pm - 2.30pm		Ryanghee Sohn *A potable electrical gait assistive system for the correction of drop foot*	Kiyoshi Oda *The auditory brainstem responses by the electrical stimulation of cochlear nucleus using multi-channel surface bipolar electrode*	Jiro Sakamoto *Stress Analysis of the Spinal Cord in Circumspinal Decompression*
2.30pm - 2.45pm	Ying Yu Chen *The Effect of Ankle Taping in Landing Deacceleration of Foot*	Yoon Hyuk Kim *Biomechanical Evaluation of Double Bundle PCL Augmentation Method*	Tetsu Tanaka *Study of Electrical Stimulation for Fully Implantable Retinal Prosthesis*	Ya-wen Kuo *The Rheological Properties of Intervertebral Disc Change with Creep Magnitude and Creep History*
2.45pm - 3.00pm	YueLin Zhang *The simulation of cerebral contusion based on judicial autopsy report*	Laura Hollingsworth *The effect of Triceps function on wheelchair propulsion for people with tetraplegia*	Shin'ichiro Kanoh *A Brain-Computer Interface (BCI) System Using Selective Attention to Auditory Streams*	
3.00pm - 3.15pm	Alan Leung *Transient Response of Surrogate Head Subjected to Local Impacts: Computational Analysis*		Yasuhisa Hirata *Human-adaptive Fitting Method of Assistive Device for Sit-to-Stand Movement*	
3.15pm - 3.30pm		Pai-Chin Tsao *The immediate effect of myofascial release on 3-dimensional scapular kinematics in patients with subacromial impingement syndrome*	Hisataka Maruyama *Fabrication of Functional Gel-Microtool for On-Chip Local Environment*	
3.30pm - 4.00pm	**Afternoon Tea** Central Lecture Block Foyer			

FRIDAY 17 APRIL (continued)

4.00pm - 5.30pm	**Oral Presentation Session 7** **Commerce 009** **Biorheology & Microcirculation**	**Commerce 011** **Cellular & Tissue Engineering & Biomaterials**	**Commerce 012** **System Level NanoBNE** **Global COE Session** **Chair: Hiroshi Kanai**	**Commerce 013** **Musculo-Skeletal Biomechanics 3**
4.00pm - 4.15pm	Yohsuke Imai *A Micro Scale Blood Flow Model to Study Pathology of Malaria*	Hiroshi Miyazaki *Comparison of strains in fibroblasts embedded in collagen matrix with applied matrix strain*	Takami Yamaguchi *Computational Biomechanics of the Human Cardiovascular System - an overview*	Kumar Mithraratne *Knee Contact Forces During Gait: Part 1 - Joint kinematics and muscle force optimisation*
4.15pm - 4.30pm	Ken-ichi Tsubota *Computer simulation study on blood cell motion near vessel wall under viscous flow with adhesion force*	Hiroshi Yamada *Finite element models with dense focal adhesions reproduce the deformation of anendothelial cell under substrate stretching*	Manabu Tashiro *Human functional imaging of skeletal muscles and brain during sports activity using positron emission tomography*	David Saloner *Hemodynamic Forces in the Progression of Vascular Disease*
4.30pm - 4.45pm	Yasuhiko Sugii *Measurement of Morphological Responses of Endothelial Cells Cultured in Microchannel by Fluid Shear Stress*		Hiroshi Fukuda *Age-Related Structural Change of the Human Brain-Analysis of Brain Magnetic Resonance Image of Healthy Japanese Subjects*	Anthony John Medland *Modelling the movements of the human hand*
4.45pm - 5.00pm	Takuji Ishikawa *Motion of individual red blood cells in a concentrated suspension flowing through micro-channels*	Takeru Naiki *The role of microtubules in the contraction of cardiomyocytes*	Kai Wu *Anatomical networks in the human brain revealed by regional gray matter volume with Japanese brain MRI database*	Alireza Hashemi Oskouei *Relationship between hand grip force and forearm surface EMG, a reliability study*
5.00pm - 5.15pm		Toh Siew Lok *Using the Digital Image Correlation Technique for Determination of Soft Tissue Strains*	Yasuyuki Taki *Correlation between global gray and white matters volume and age in Japanese children*	Pei-Lin Yang *Secondary motions of the humerus and scapula kinematics: arm elevation test in patients with shoulder anterior/posterior tightness.*
5.15pm - 5.30pm		Kazuo Takakuda *Accelerated fusion of surgical wound with low reactive-level laser therapy*	Tomoyuki Yambe *Effect of Alternanive medicine on Autonomic function*	Yasuhiro Matsuda *Development of Finger Braille Recognition System*

附件二：會議會場位置圖－坎特貝理大學（**University of Canterbury**）



附件三：發表論文摘要

Electromyographic Analysis of Throwing Different Types of Baseball Pitches

Yi-Wen CHANG*, Cheng-Hsin CHENG**, Chi-Cheng WANG**, Hong-Wen WU***

* Department of Exercise and Health Science, National Taiwan Sport University, Taichung, 404, Taiwan

E-mail: changyw@ntcpe.edu.tw

** Gradual School of Physical Education, National Taiwan Sport University, Taichung, 404, Taiwan

*** Department of Sports Medicine, China Medical University, Taichung, 404, Taiwan

Abstract

The purpose of this study was to investigate the difference of electromyography in arm muscles among pitching different types of balls. Surface electromyography was performed on five collegiate pitchers. Each subject threw the fastball, slider and change-up. Linear envelope was computed for each muscle. Electromyographic activity of biceps brachii in fastball was significantly greater than the activities in slider and change-up. Electromyographic activity of anterior deltoid in slider was significantly lesser than the activities in fastball and change-up. Electromyographic activity of latissimus dorsi in fastball was significantly greater than the activity in slider. Different muscle activities were found in arm in throwing different types of baseball pitches.

Key words: Electromyography, Baseball pitching, Slider, Fastball, Change-up

1. Introduction

Pitcher's performance is one of the most important factors for winning in baseball competition. The purpose of this study was to investigate the difference of electromyography (EMG) in arm muscles among pitching different types of balls.

2. Methods

Five collegiate pitchers were participated in this study. Surface electromyography (MA310) was used to measure the activity of biceps brachii, triceps brachii, anterior deltoid, posterior deltoid and latissimus dorsi. The sampling rate was 1000 Hz. Each subject threw the fastball, slider and change-up for five trials. Linear envelope was computed. EMG activity was normalized by maximum EMG for each subject. One-way ANOVA with repeated measures was used for statistical analysis.

3. Results

EMG activity of biceps brachii in fastball (70%max) was significantly greater than the activities in slider (61%max) and change-up (60%max) ($p<.05$). EMG activity of anterior deltoid in slider (52%max) was significantly lesser than the activities in fastball (73%max) and change-up (63%max) ($p<.05$). EMG activity of latissimus dorsi in fastball (64%max) was significantly greater than the activity in slider (52%max) ($p<.05$). There was no significant difference in other measuring muscles among pitching different types of balls.

4. Discussion

Compared with the slider and change-up, biceps brachii and lastissimus dorsi, with higher EMG activities, were dominant in pitching fastball. Compared with the fastball and change-up, anterior deltoid had lesser EMG activity in pitching slider. Based on our findings, the strategy of muscle contraction in arm might be different during pitching different types of balls.

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