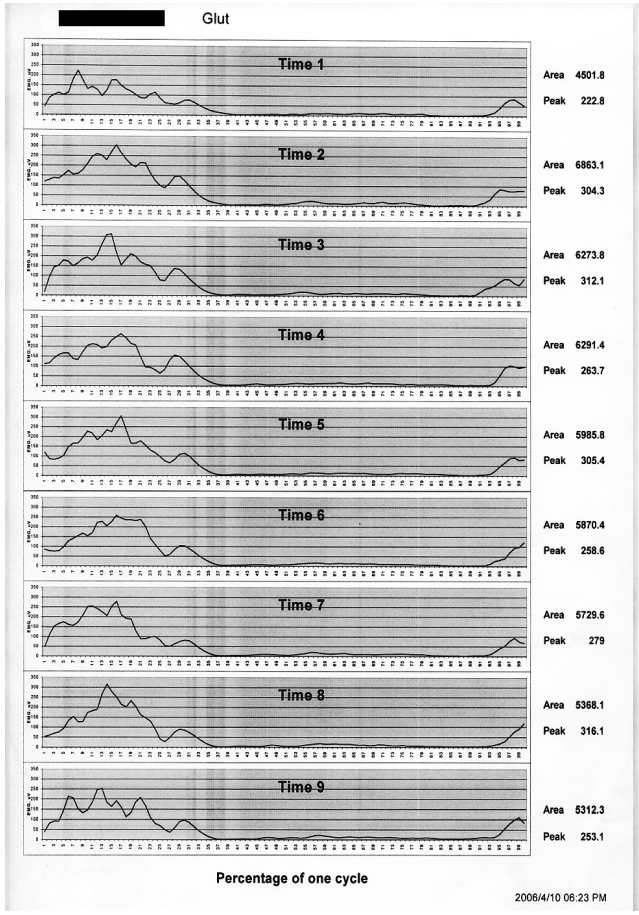
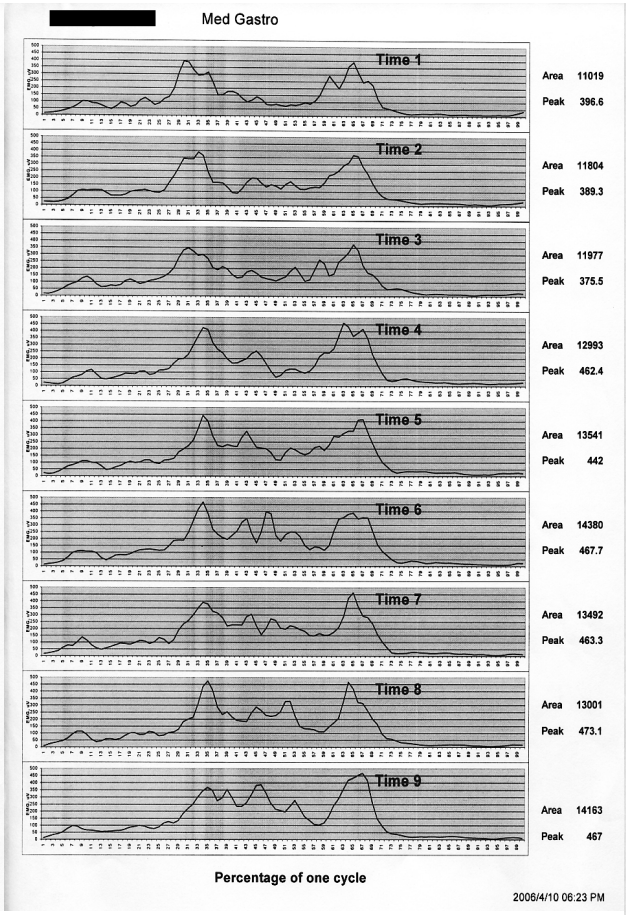
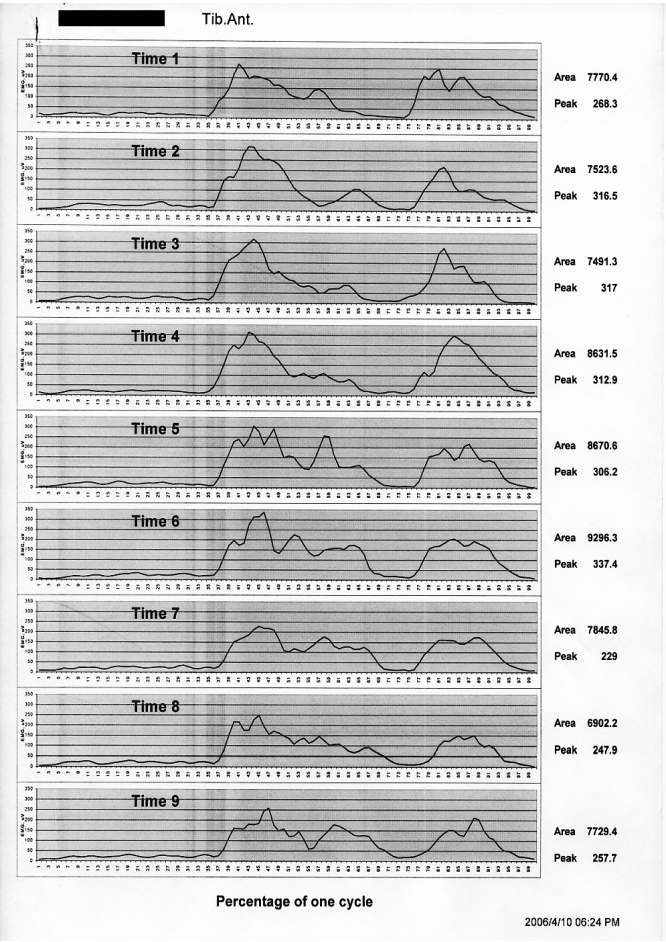
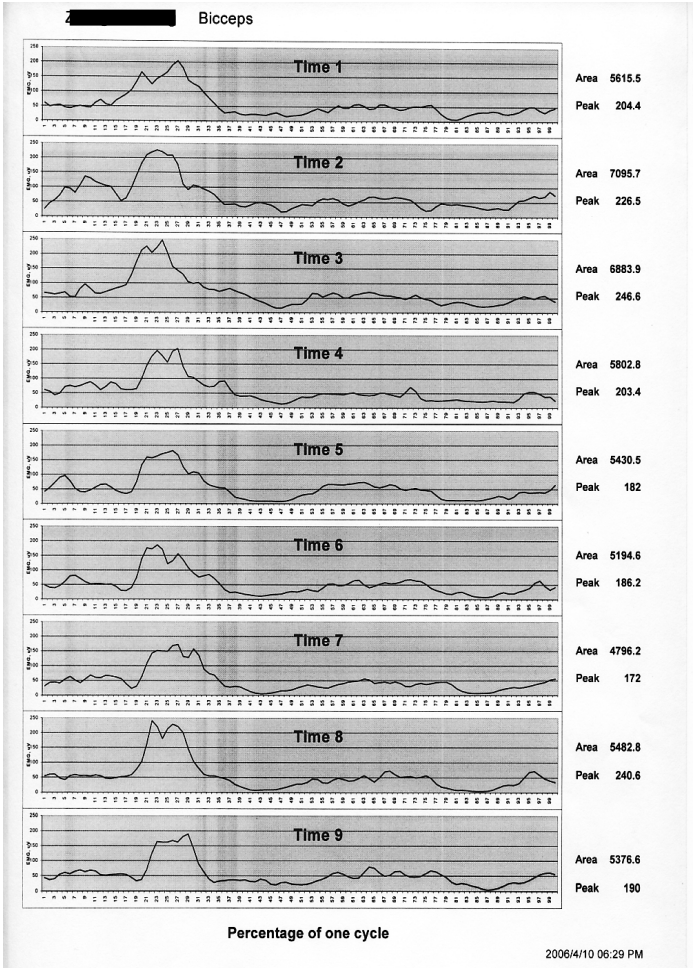
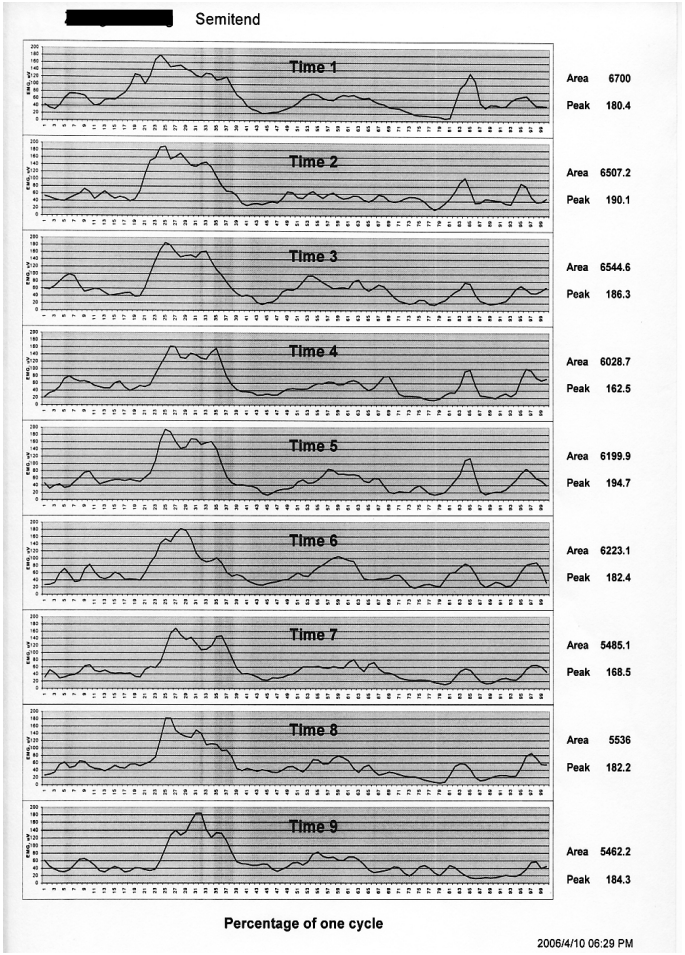

[redacted] Glut
Time 1
Area 4501.8
Peak 222.8
Time 2
Area 6863.1
Peak 304.3
Time 3
Area 6273.8
Peak 312.1
Time 4
Area 6291.4
Peak 263.7
Time 5
Area 5985.8
Peak 305.4
Time 6
Area 5870.4
Peak 258.6
Time 7
Area 5729.6
Peak 279
Time 8
Area 5368.1
Peak 316.1
Time 9
Area 5312.3
Peak 253.1
Percentage of one cycle
2006/4/10 06:23 PM

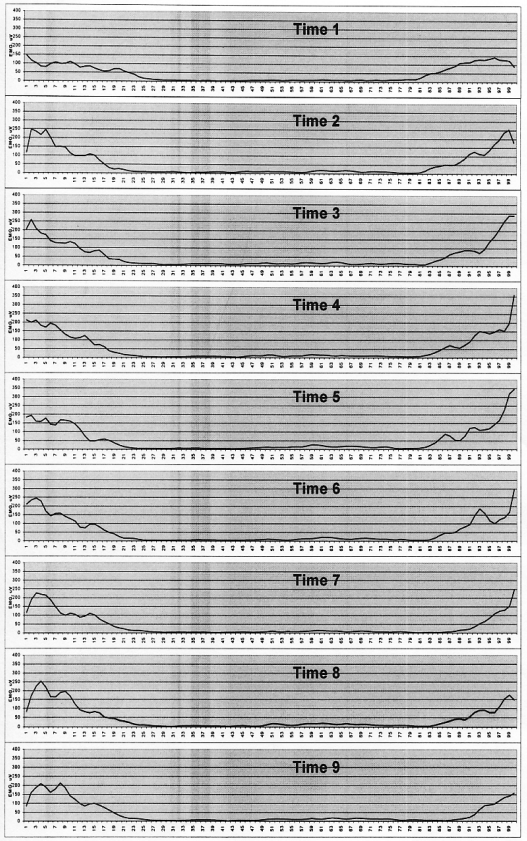

[redacted] Med Gastro
Time 1
Area 11019
Peak 396.6
Time 2
Area 11804
Peak 389.3
Time 3
Area 11977
Peak 375.5
Time 4
Area 12993
Peak 462.4
Time 5
Area 13541
Peak 442
Time 6
Area 14380
Peak 467.7
Time 7
Area 13492
Peak 463.3
Time 8
Area 13001
Peak 473.1
Time 9
Area 14163
Peak 467
Percentage of one cycle
2006/4/10 06:23 PM


[redacted] Tib.Ant.
Time 1
Area 7770.4
Peak 268.3
Time 2
Area 7523.6
Peak 316.5
Time 3
Area 7491.3
Peak 317
Time 4
Area 8631.5
Peak 312.9
Time 5
Area 8670.6
Peak 306.2
Time 6
Area 9296.3
Peak 337.4
Time 7
Area 7845.8
Peak 229
Time 8
Area 6902.2
Peak 247.9
Time 9
Area 7729.4
Peak 257.7
Percentage of one cycle
2006/4/10 06:24 PM


[redacted] Bicceps
Time 1
Area 5615.5
Peak 204.4
Time 2
Area 7095.7
Peak 226.5
Time 3
Area 6883.9
Peak 246.6
Time 4
Area 5802.8
Peak 203.4
Time 5
Area 5430.5
Peak 182
Time 6
Area 5194.6
Peak 186.2
Time 7
Area 4796.2
Peak 172
Time 8
Area 5482.8
Peak 240.6
Time 9
Area 5376.6
Peak 190
Percentage of one cycle
2006/4/10 06:29 PM


[redacted] Semitend
Time 1
Area 6700
Peak 180.4
Time 2
Area 6507.2
Peak 190.1
Time 3
Area 6544.6
Peak 186.3
Time 4
Area 6028.7
Peak 162.5
Time 5
Area 6199.9
Peak 194.7
Time 6
Area 6223.1
Peak 182.4
Time 7
Area 5485.1
Peak 168.5
Time 8
Area 5536
Peak 182.2
Time 9
Area 5462.2
Peak 184.3
Percentage of one cycle
2006/4/10 06:29 PM

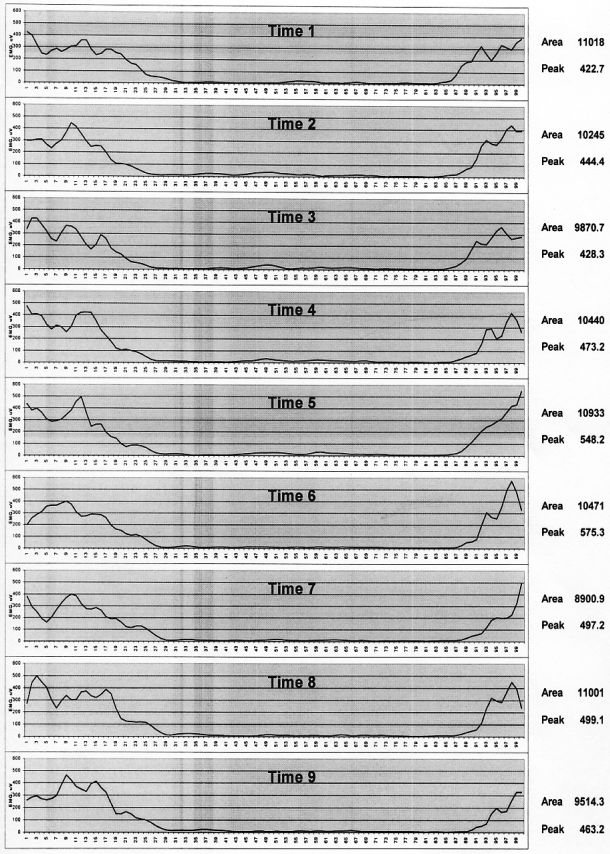
[redacted] RF



Percentage of one cycle

2006/4/10 06:27 PM

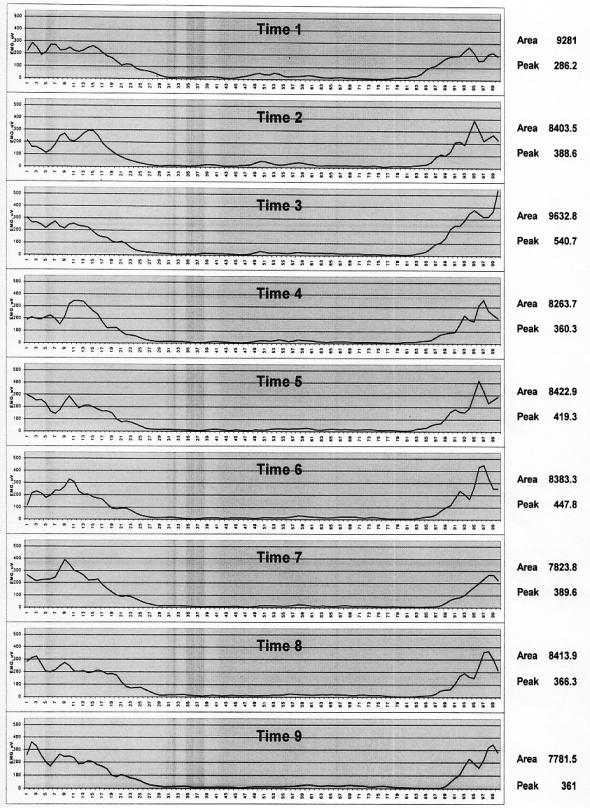
[redacted] VLO



Percentage of one cycle

2006/4/10 06:28 PM

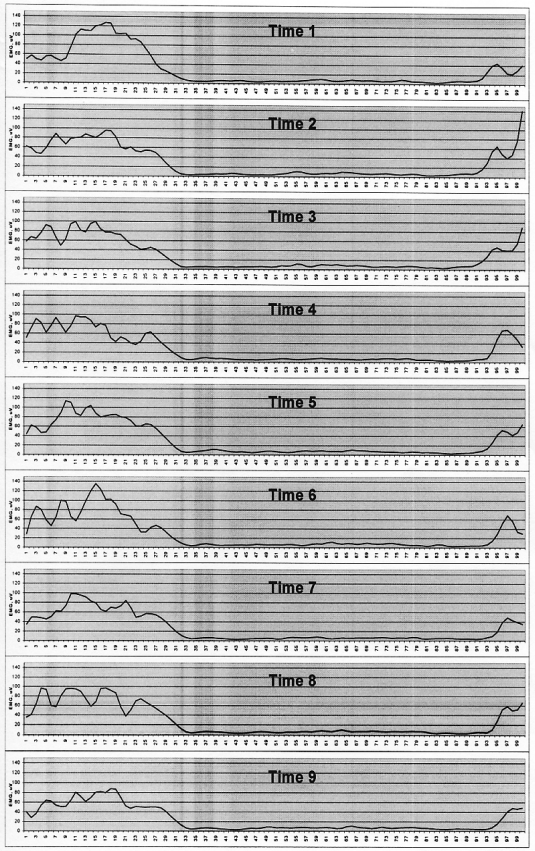
[redacted] VMO



Percentage of one cycle

2006/4/10 06:28 PM

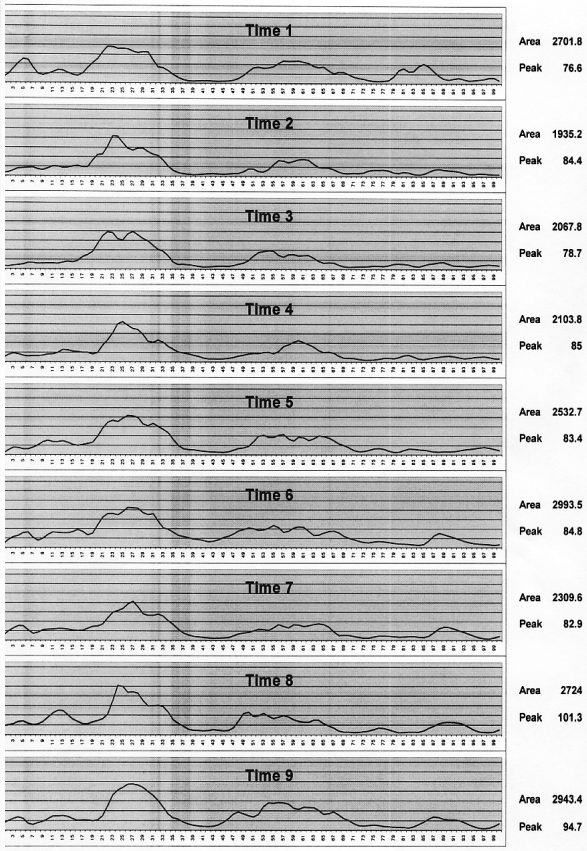
[redacted] Glut



Percentage of one cycle

2006/4/10 06:29 PM

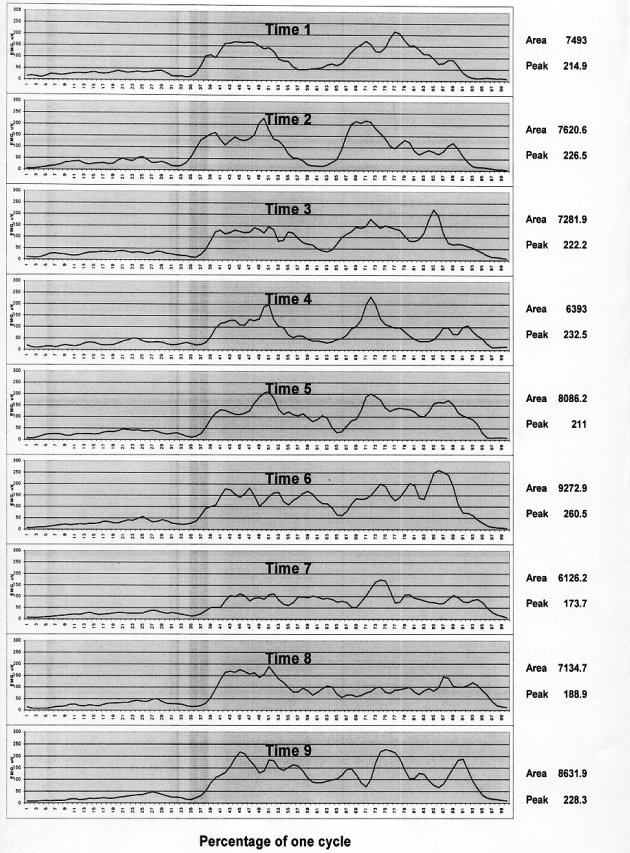
[redacted] Med Gastro



Percentage of one cycle

2006/4/10 06:30 PM

[redacted] Tib.Ant.



Percentage of one cycle

2006/4/10 06:30 PM

Cross-correlation

- Cross-correlation was employed to quantify the phase shift of the EMG rms value pattern between time points
- Time point one is defined as the base level and the other time points were compared with it to quantify the muscles activity shift and for cross comparison.

Coefficient of cross correlation

Li Li [a,*], Graham E. Caldwell [b]

Journal of Electromyography and Kinesiology 9 (1999) 385–389

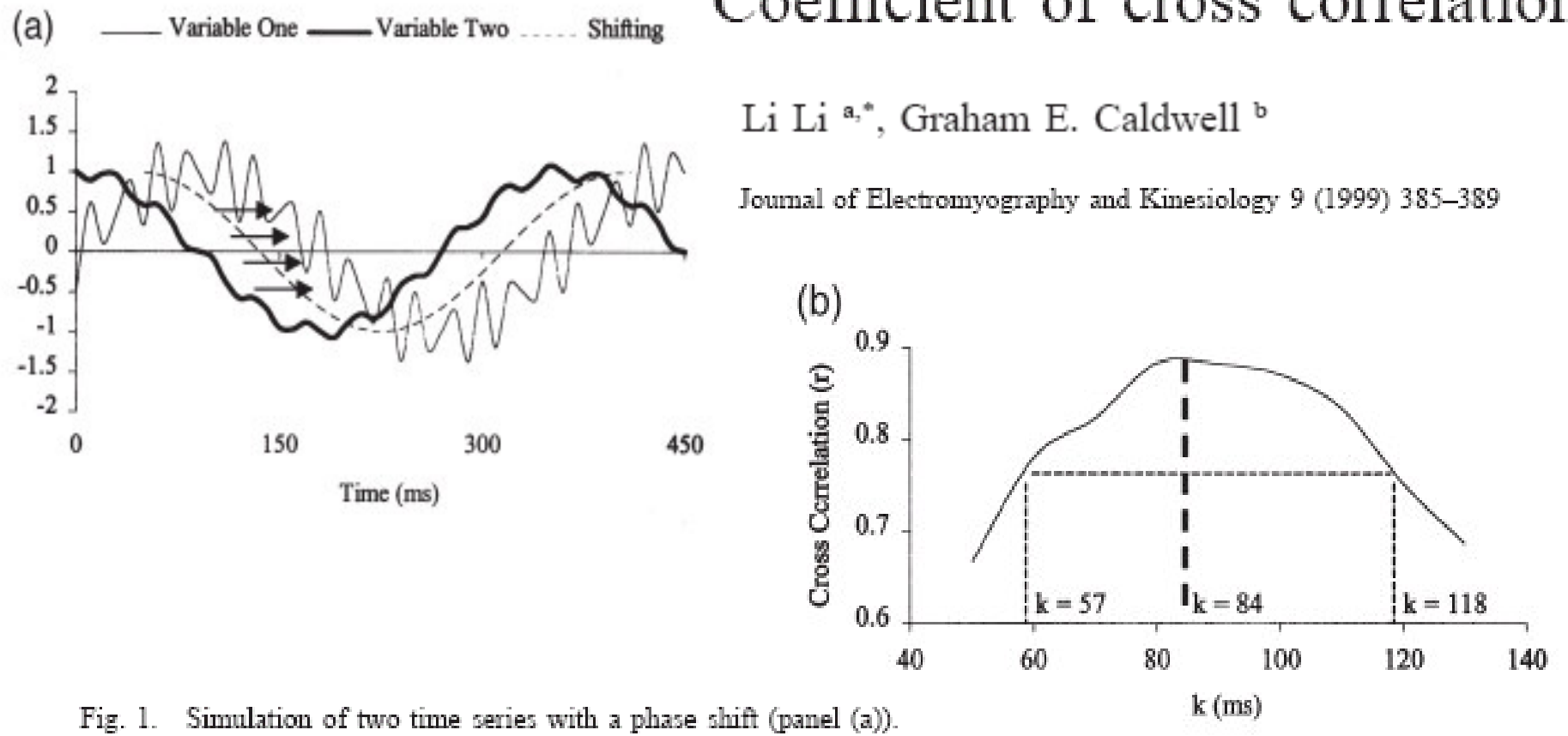
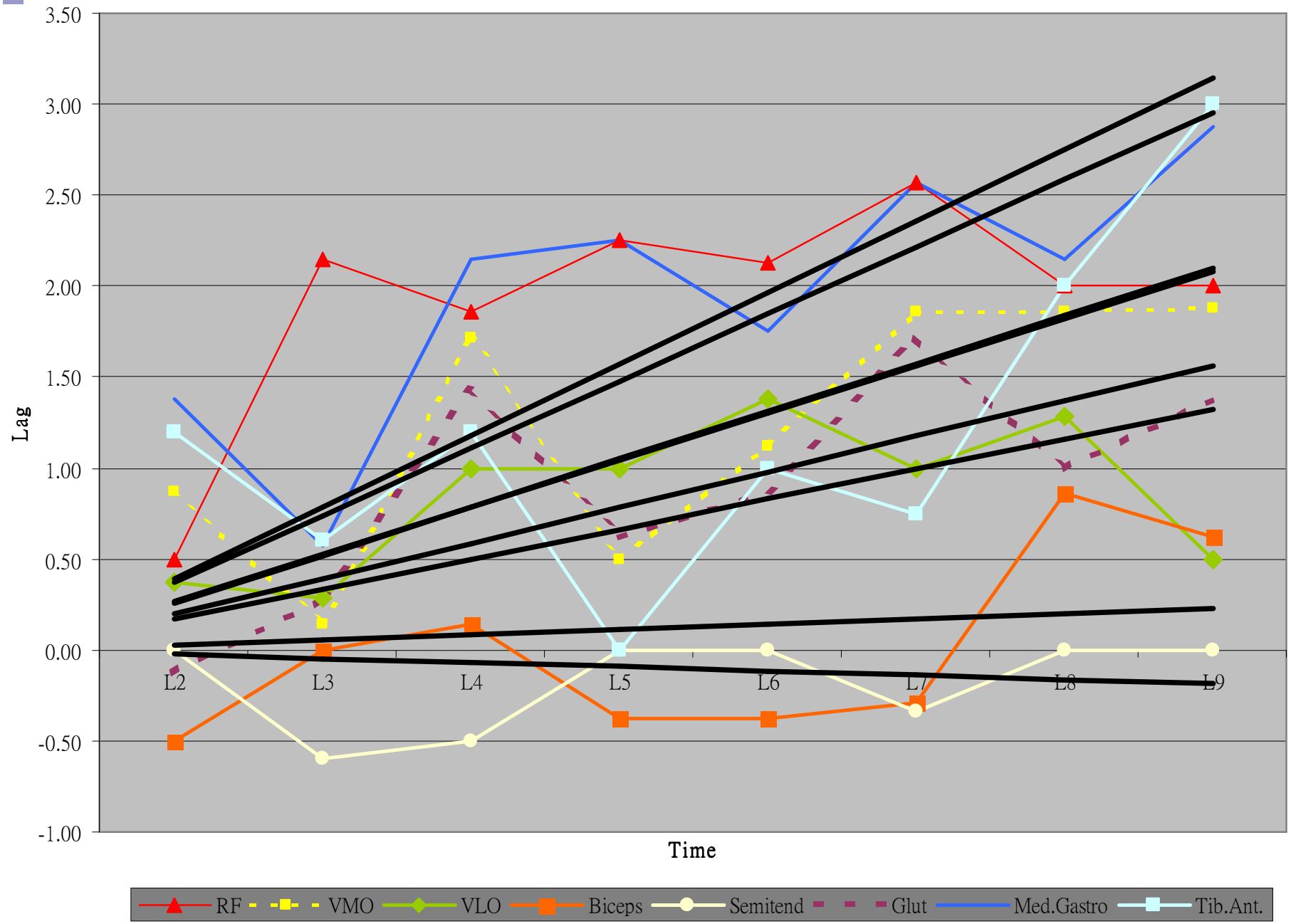


Fig. 1. Simulation of two time series with a phase shift (panel (a)). The cross-correlation coefficient for the original data (variable one and two, v_1 and v_2) is r_{xy} (0) = −0.015. By shifting v_2 relative to v_1 in the time domain by successive increment of k, $r_{xy}(k)$ can be found for all values of k (panel (b)). r_{xy} (84 ms) =0.883 is the greatest correlation coefficient that can be achieved by this shifting process. Therefore, 84 ms is the phase difference between the two series. The corresponding times of the lower 95% confidence interval (CI) of r_{xy} are 57 and 118 ms. The conclusion from this calculation is that the shift represented by the greatest r_{xy} is significant because 0 ms is not included in the range from 57 to 118 ms.

The time series shift during the 5-minute cycling

Muscles	Statisics	L2	L3	L4	L5	L6	L7	L8	L9	Average
RF	Mean	**0.50**	**2.14**	**1.86**	**2.25**	**2.13**	**2.57**	**2.00**	**2.00**	**1.93**
N=8	SD	0.93	3.67	5.24	4.30	4.82	4.16	3.32	3.78	
VMO	Mean	**0.88**	**0.14**	**1.71**	**0.50**	**1.13**	**1.86**	**1.86**	**1.88**	**1.24**
N=8	SD	1.25	0.38	2.93	1.77	2.10	2.41	2.67	2.75	
VLO	Mean	**0.38**	**0.29**	**1.00**	**1.00**	**1.38**	**1.00**	**1.29**	**0.50**	**0.85**
N=8	SD	0.74	0.76	1.73	1.77	2.26	2.08	1.70	2.33	
Biceps	Mean	**-0.50**	**0.00**	**0.14**	**-0.38**	**-0.38**	**-0.29**	**0.86**	**0.63**	**0.01**
N=8	SD	1.41	0.00	1.95	2.00	1.51	0.76	2.48	1.19	
Semitend	Mean	**0.00**	**-0.60**	**-0.50**	**0.00**	**0.00**	**-0.33**	**0.00**	**0.00**	**-0.18**
N=8	SD	0.00	1.34	1.22	0.00	0.00	0.82	0.00	0.00	
Glut	Mean	**-0.13**	**0.29**	**1.43**	**0.63**	**0.88**	**1.71**	**1.00**	**1.38**	**0.90**
N=8	SD	0.35	0.76	1.62	2.26	1.64	2.06	3.46	2.00	
Med.Gastro	Mean	**1.38**	**0.57**	**2.14**	**2.25**	**1.75**	**2.57**	**2.14**	**2.88**	**1.96**
N=8	SD	1.19	1.13	2.27	2.60	1.91	2.82	2.85	3.09	
Tib.Ant	Mean	**1.20**	**0.60**	**1.20**	**0.00**	**1.00**	**0.75**	**2.00**	**3.00**	**1.22**
N=5	SD	1.10	2.51	2.68	0.00	2.24	1.50	2.45	3.00	

The shifting for each muscle along the time



APPLICATION OF SURFACE ELECTROMYOGRAPHY (WAVELET) IN ASSESSING MUSCLE FATIGUE PATTERNS IN A FIVE-MINUTE CONTINUOUS CYCLING EFFORT

XXIX FIMS World Congress of Sports Medicine
2006 北京FIMS世界运动医学大会
Beijing, China, 14-16 June 2006

Effect of transcutaneous electrical acupoint stimulation (TEAS) on fatigue recovery of knee muscles

[1,2]Raymond SO
[1]Gabriel NG
[1]Joseph NG
[1]Department of Rehabilitation Sciences,
The Hong Kong Polytechnic University
[2]Department of Sports Science,
The Hong Kong Sports Institute

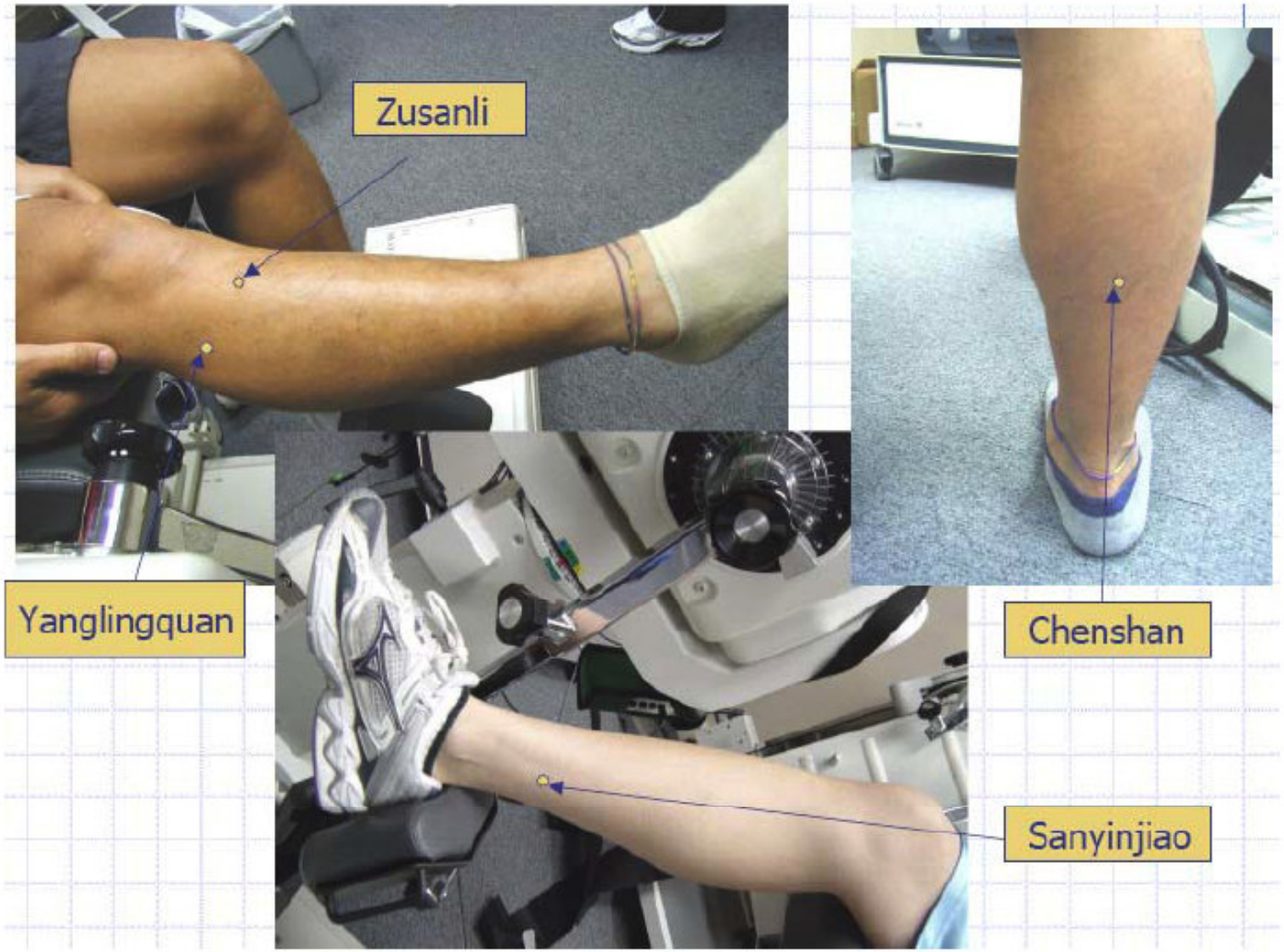


Diagram 2. The location of the four acupoints.

TENS 120Z (ITO. CO., Japan)

SPECIFICATIONS

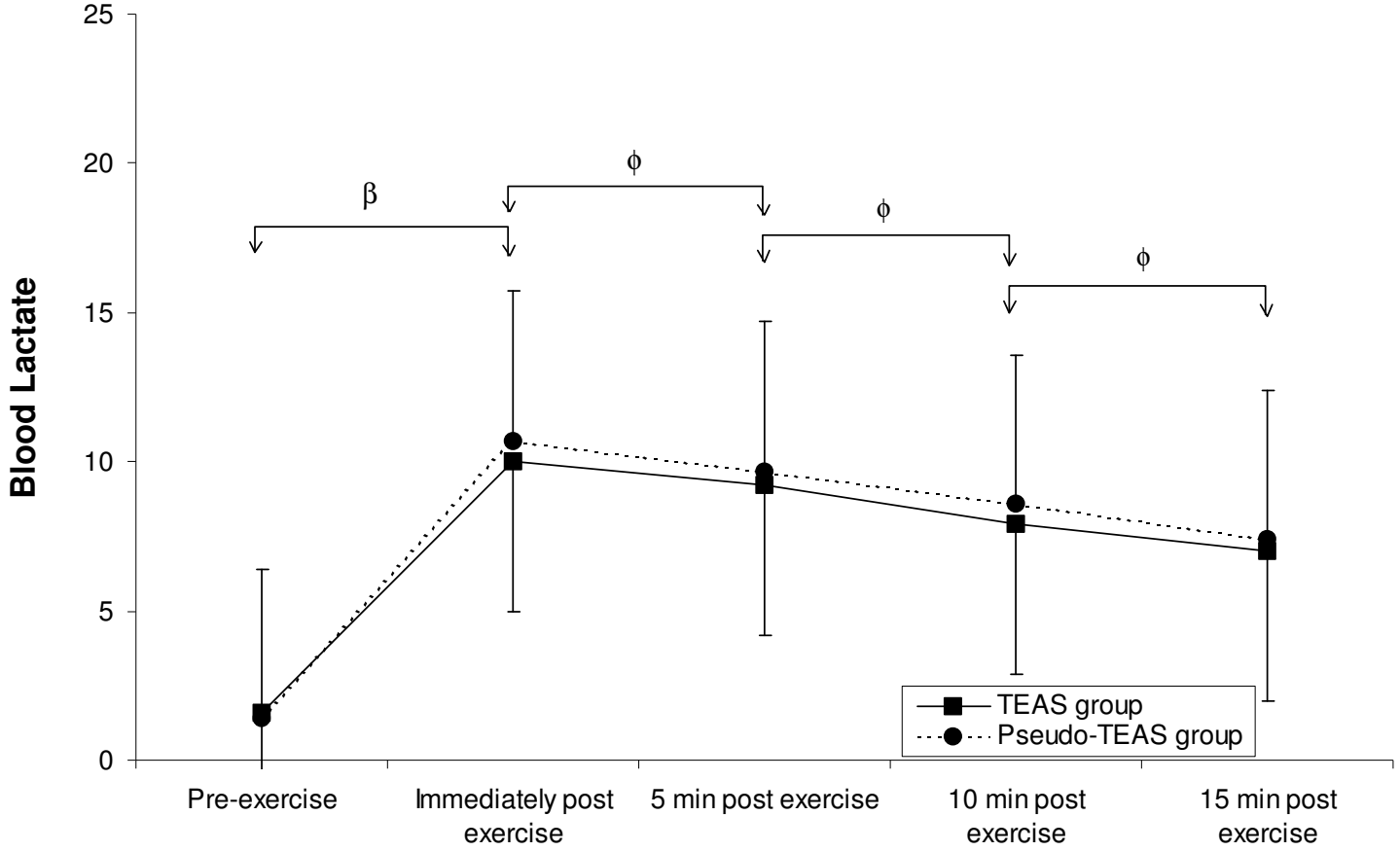
No. of Channel	2 channels
Pulse Shape	Asymmetric bi-phase rectangular pulse
Amplitude	80mA peak at 500ohm load
Phase Duration	50-200μs steplessly adjustable
Frequency	(1) Constant mode: 2-200 pulses per second (2) Modulation mode: 2-200 pulses per second, 2 seconds-On and 1 second-Rest (3) Burst mode: 2 bursts per second, fixed
Power Source	9V battery
Conformity	CE(MDD), FDA
Dimensions	96 x 61 x 27mm
Weight	142 gr. including a battery

Total work output during the test exercise

	TEAS			Pseudo-TEAS		
	Set 1	Set 2	**Total**	Set 1	Set 2	**Total**
Work (J)	4561.3	3346.0	**7907.4**	4556.7	3394.0	**7650.7**
SD	1321.0	901.1	**2176.4**	1193.4	816.5	**1987.2**

No sig. diff. ($p>0.05$)

Blood Lactate measured at the Pre. Immediate . 5min. 10min and 15 min post exercise test



Main Effect (Recovery):

Treatment: p=0.147

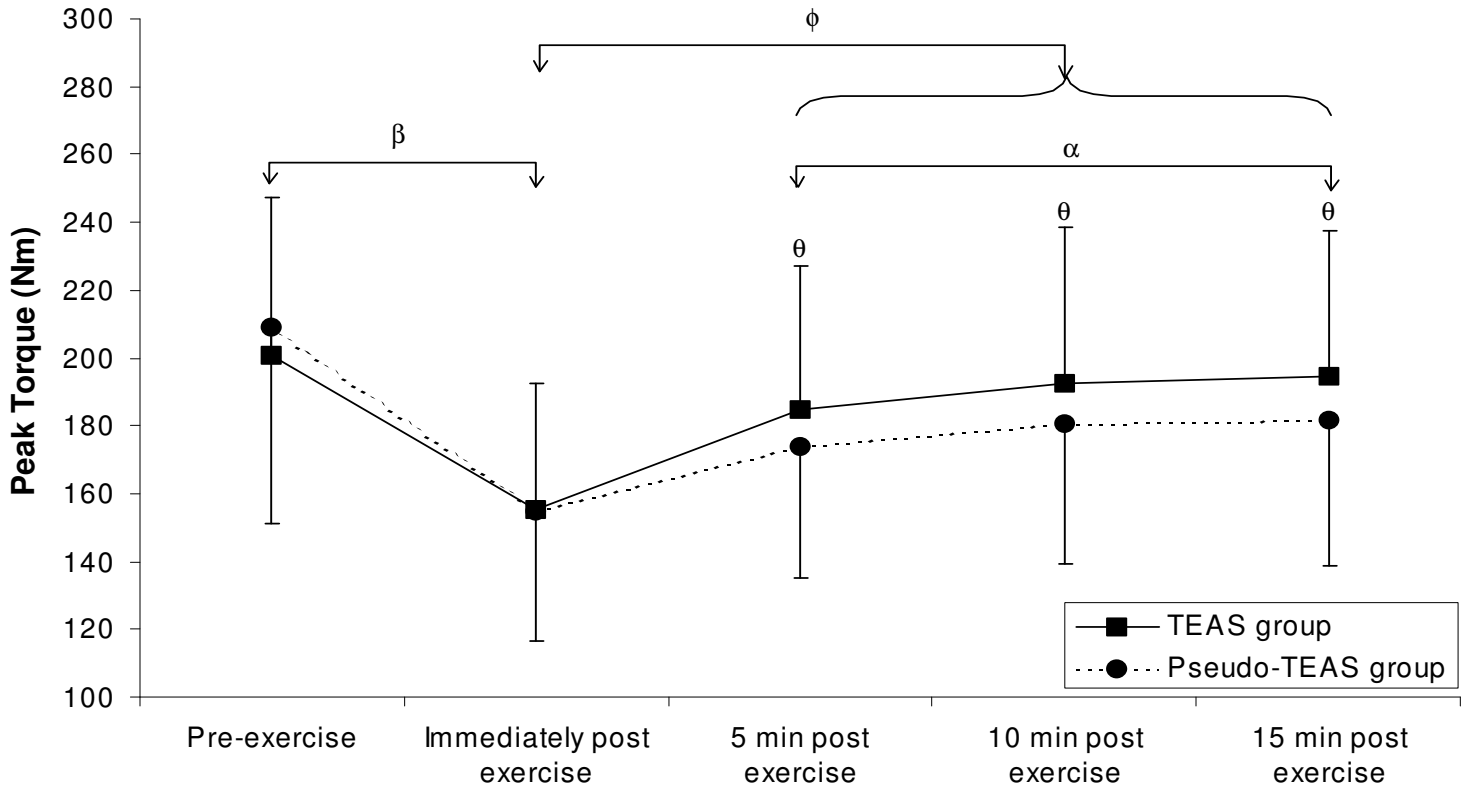
Time: p=<0.001

Treatment*Time p=0.634

β : significant difference between the pre- and post exercise test in both treatment groups

ϕ : significant difference between time points in both treatment groups during recovery

Knee extension peak torque measured at the Pre, Immediate , 5min, 10min and 15 min post exercise test



Main Effect (Recovery) :

Treatment:	p=0.029
Time:	p=<0.001
Treatment*Time	p=0.082

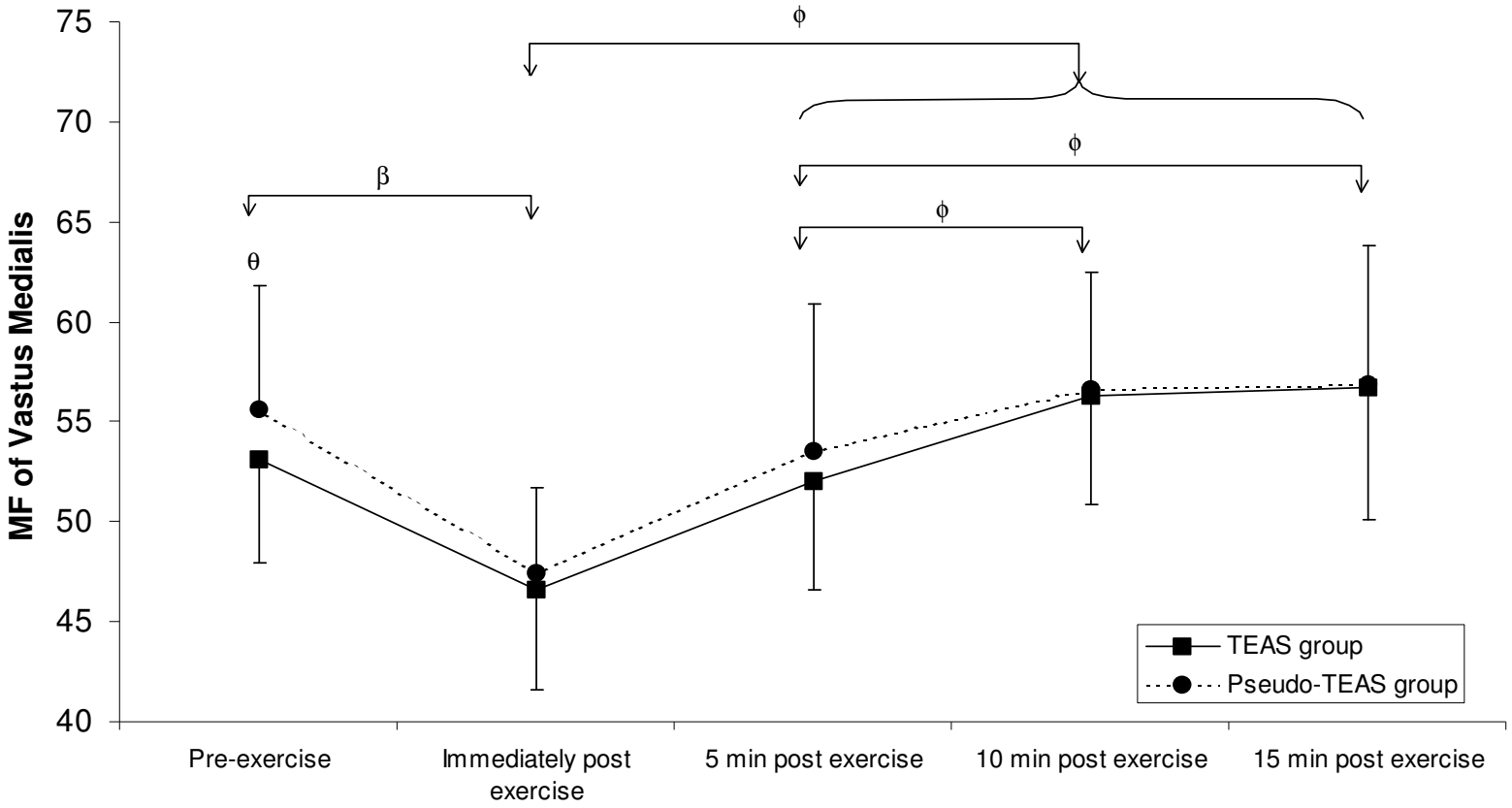
β : significant difference between the pre- and post exercise test in both treatment groups

θ : significant difference between the TEAS and the Pseudo-TEAS groups

ϕ : significant difference between time points in both treatment groups during recovery

α : significant difference between time points in the TEAS group during recovery

MF of Vastus Medialis measured at the Pre, Immediate , 5min, 10min and 15 min post exercise test



Main Effect (Recovery) :

Treatment: p=0.376

Time: p=<0.001

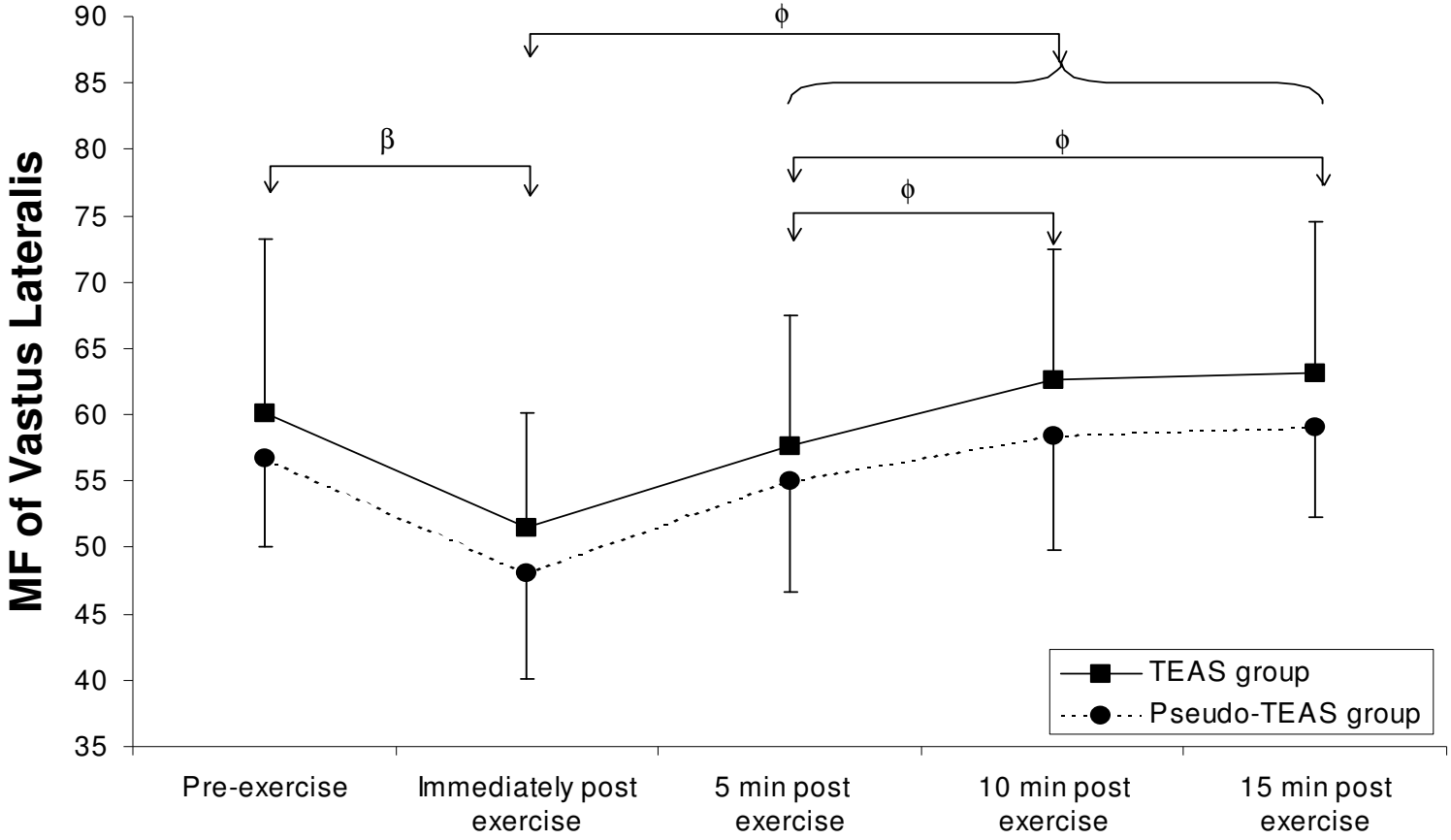
Treatment*Time p=0.975

β : significant difference between the pre- and post exercise test in both treatment groups

θ : significant difference between the TEAS and the Pseudo-TEAS groups

ϕ : significant difference between time points in both treatment groups during recovery

MF of Vastus Lateralis measured at the Pre, Immediate , 5min, 10min and 15 min post exercise test



Main Effect (Recovery) :

Treatment: p=0.086

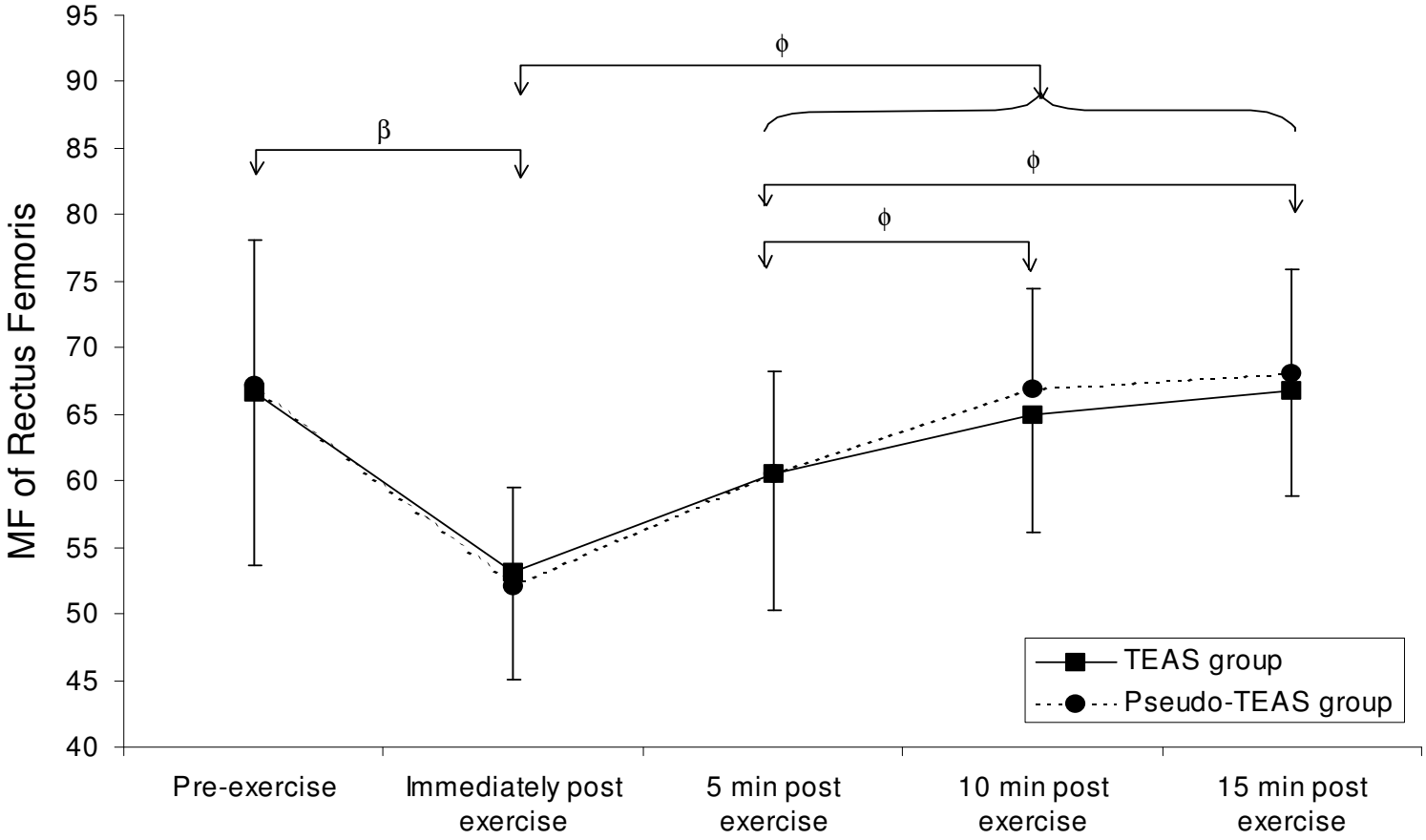
Time: p=<0.001

Treatment*Time p=0.911

β : significant difference between the pre- and post exercise test in both treatment groups

ϕ : significant difference between time points in both treatment group during recovery

MF of Rectus Femoris measured at the Pre, Immediate , 5min, 10min and 15 min post exercise test



Main Effect (Recovery) :

Treatment: p=0.472

Time: p=<0.001

Treatment*Time p=0.509

β : significant difference between the pre- and post exercise test in both treatment groups

ϕ : significant difference between time points in both treatment group during recovery

Measurement of fatigue:

- Continuous and accurate

- Importance in understanding the ergonomics and physiology of work and sport induced injury.

- Improved working practices and sport techniques, training and testing can then results. **(Seghers & Spaepen 2004, Bystrom & Fransson-Hall 1994)**

Conclusion

- Because of the compensatory mechanism, work stress will be shared between muscles during the task
- On injury and performance concern:
  - The starting strength
  - Muscle fatigue tolerance
  - Knowing the compensatory sequence

Thank you !

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