BOOK OF ABSTRACTS **Open Access**

An investigation of the biomechanical efficacy and clinical effectiveness of patello-femoral taping in elite and experienced cyclists

G Theobald [1]✉, J Selfe [2], J Richards [2] and H Roddam [2]

Abstract

Background: From high profile events such as the Tour De France and the Olympics, it is noticeable that kinesiology type taping (KTT) is used widely within elite cycling for treatment of knee pain. Taping is a clinical treatment for the over-use/overload pathology of patello-femoral pain (PFP) in elite and experienced cyclists, however it is unknown as to whether it effects any biomechanical change that can be useful in a clinical setting. PFP in cycling is often referred to as cyclists' knee or anterior knee pain, and has been reported to occur in over 25% of all cyclists. (Callaghan, 2005: Journal of Bodywork and Movement Therapies, 9, 226-236). Some cyclists are pre-disposed to excessive knee movement during the pedal stroke (Bailey et al, 2003: Journal of Sports Sciences, 21 (2), 649–657), and consequently at different power levels and cadences this movement may affect biomechanical factors at the knee. An increased understanding of taping and the biomechanics of the knee during cycling could greatly improve the active prevention and treatment of overuse problems during cycling.

Purpose: To determine and evaluate any biomechanical changes around the knee in elite and experienced cyclists both with and without knee pain, using established taping techniques at varying powers.
Methods: 12 asymptomatic participants and 8 symptomatic participants conducted three separate tests at three powers (100w, 200w & 300w) on a static trainer using a Powertap™ rear wheel and their own bike (fig 1). The study was conducted under three randomised conditions a) no tape, b) placebo tape, c) Kinesiology type tape (fig 2). Kinematic data were collected using a 10-camera Qualysis motion analysis system (fig 3). Reflective markers were placed on the foot, shank, thigh and pelvis using the CAST technique (fig 4). Visual 3D software was used to export to SPSS (fig 5&6).

Results: Measurements and statistical analysis were undertaken in the knee, hip and ankle/foot. Mixed methods and repeated-measures two-way ANOVA test were performed together with posthoc Pairwise comparison with Bonferroni adjustment to examine differences in three-dimensional movement under the different conditions/powers. Results were presented in kinematic pattern, range of motion (ROM) and statistical differences (fig 6,7,8) for comprehensive clinical application and relevance. Alongside this, a new approach was investigated to measure the knee 'in relation to' both the hip/pelvis and ankle/foot (fig 6). Results indicate statistical differences between conditions and powers (Fig 7) however at this stage their clinical significance has not yet been fully determined. The lower powers indicate instability and the higher powers indicate changes both distally and proximally to the knee. There appears to be a separation in the differences between cyclists tested with and without pain, however this does not necessarily indicate that KTT produces this in isolation. The differences vary across conditions and powers.

Discussion: It is noticeable that the knee is not the only implicated joint in cycling related knee pain and taping. In fact all the recent evidence in this area indicate that distal and proximal to the knee are key factors (Powers et al, 2013: Journal Orthop Sports Physical Therapy. 42 (6), A1-54). In line with this evidence both the hip/pelvis and foot indicate changes that may be relevant to clinical application of taping with cyclists. It remains possible that there is a link between these movement patterns and cycling related knee pain however further work is required to fully determine this. The answer to the question does tape change what is happening at the knee is yes. Does it do different things with those with pain? Again, yes, to some degree. That said however, the clinical relevance requires a deeper analysis of the kinematic pattern data alongside the range of motion. The work undertaken to date in this project indicates the complexities of both human movement and the variables of a highly repetitive sport. The statistical change in the sagittal plane may indicate a muscular effect from taping however there were also changes by neutral taping which is interesting considering the specific nature of the KTT technique. Perhaps this specificity is not as critical as often indicated by manufacturers?

Conclusion: Cycling related knee pain is a complex and under-researched area and we understand little of its treatment efficacy and effectiveness. Further work is required to investigate the relationship within the kinematics measured in this study. Distal and proximal effects are broadly in line with gait-based evidence. For clinical significance the statistics, kinematic patterns and ROM need to be considered as a whole. Specific application of tape technique may not be critical to achieve a measurable change.

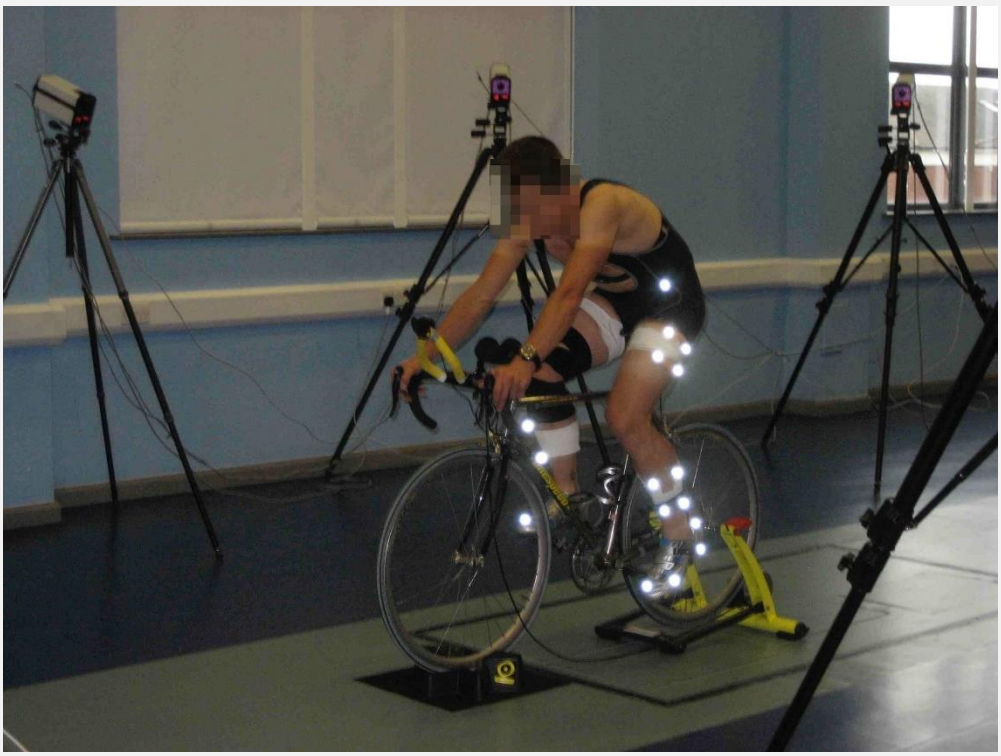


Figure 1. Participant on bike during testing.

Figure 2. KTT technique on participant.

Figure 3. Lab set up (with and without bike).

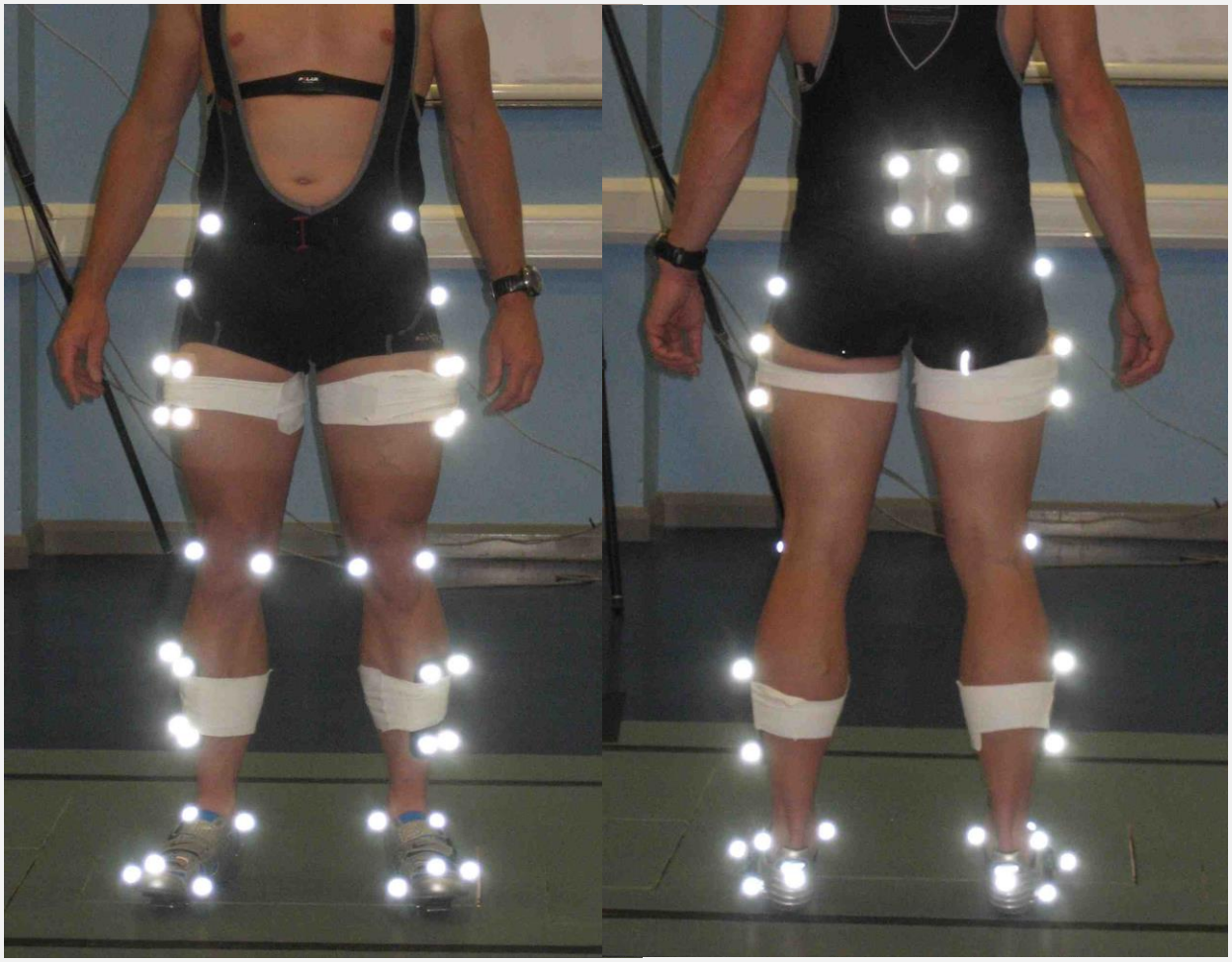


Figure 4. Anterior and posterior marker view.

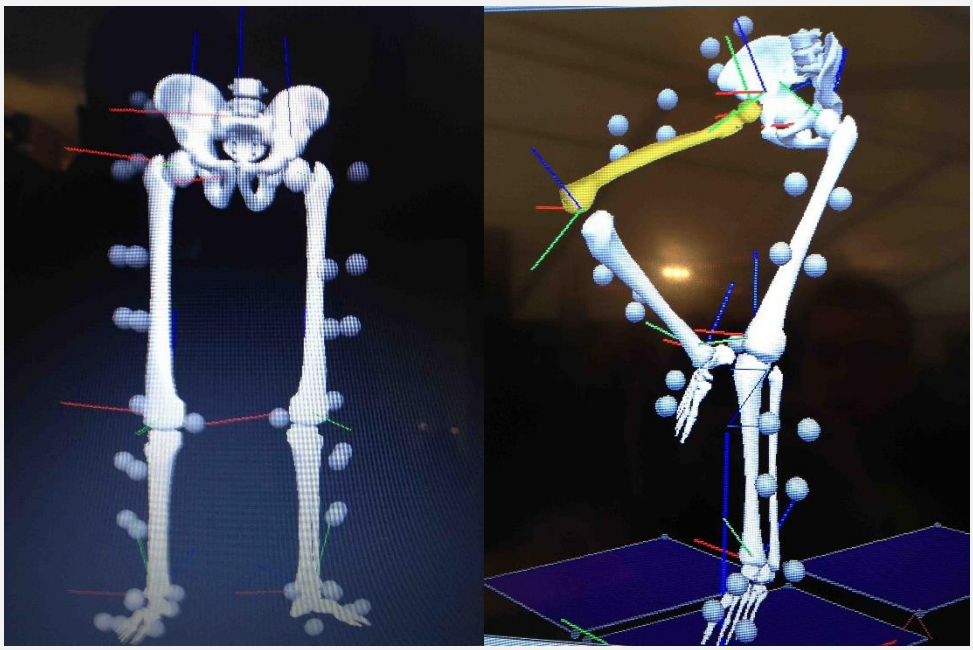


Figure 5. Visual 3D software screenshot.

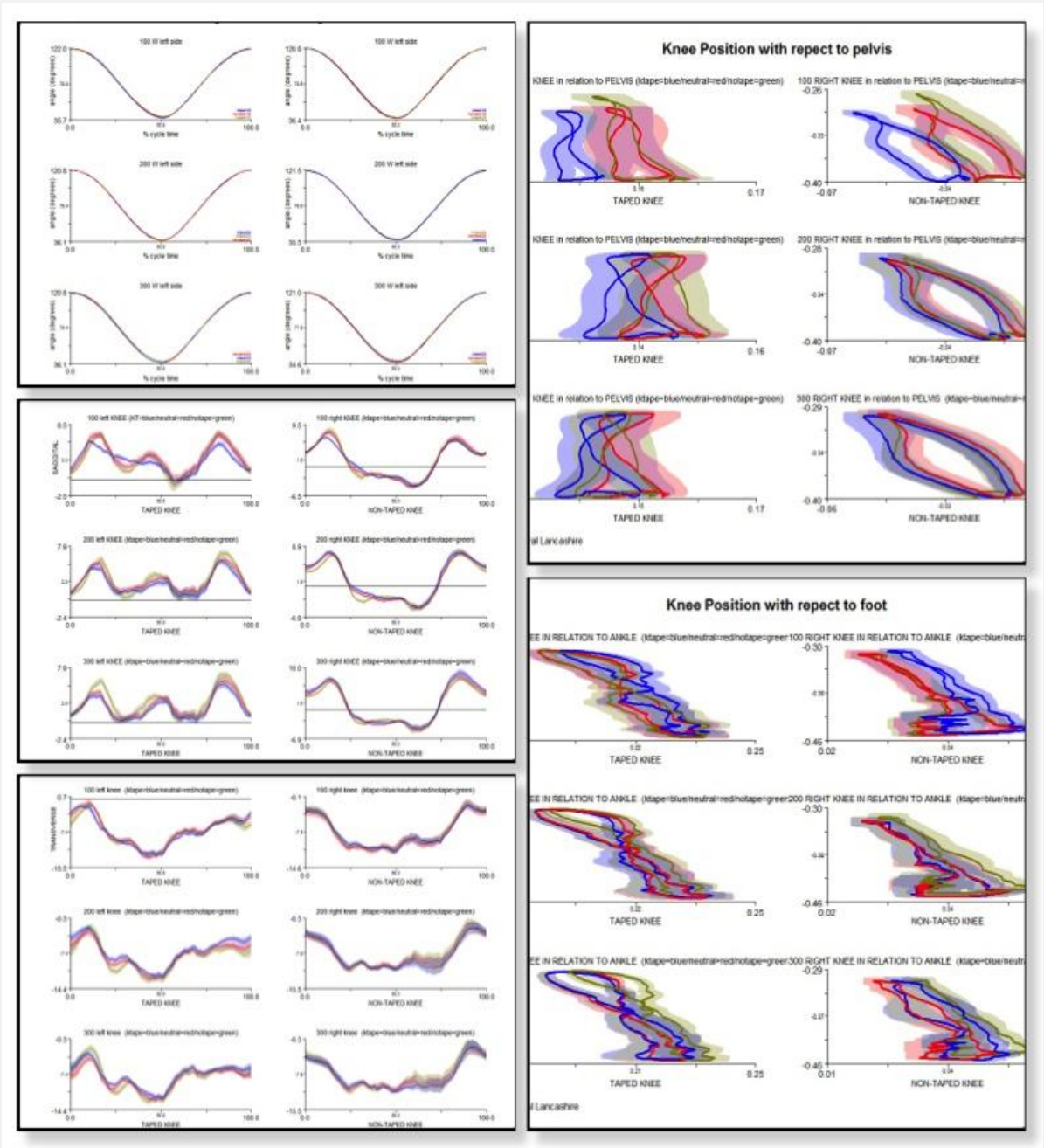
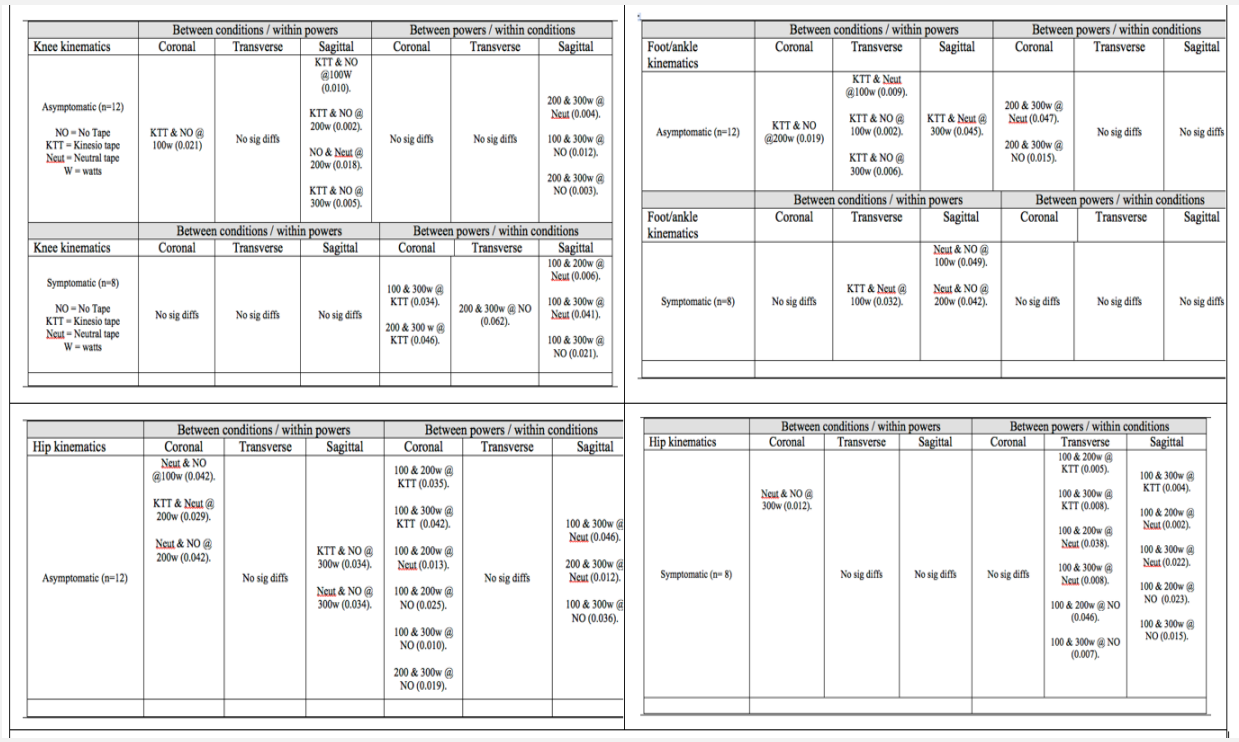


Figure 6. Knee Kinematic patterns (clockwise from top – knee to pelvis, knee to foot, transverse, coronal, sagittal).



	Between conditions / within powers			Between powers / within conditions		
Knee kinematics	Coronal	Transverse	Sagittal	Coronal	Transverse	Sagittal
Asymptomatic (n=12) NO = No Tape KTT = Kinesio tape Neut = Neutral tape W = watts	KTT & NO @ 100w (0.021)	No sig diffs	KTT & NO @100W (0.010). KTT & NO @ 200w (0.002). NO & Neut @ 200w (0.018). KTT & NO @ 300w (0.005).	No sig diffs	No sig diffs	200 & 300w @ Neut (0.004). 100 & 300w @ NO (0.012). 200 & 300w @ NO (0.003).

	Between conditions / within powers			Between powers / within conditions		
Knee kinematics	Coronal	Transverse	Sagittal	Coronal	Transverse	Sagittal
Symptomatic (n=8) NO = No Tape KTT = Kinesio tape Neut = Neutral tape W = watts	No sig diffs	No sig diffs	No sig diffs	100 & 300w @ KTT (0.034). 200 & 300 w @ KTT (0.046).	200 & 300w @ NO (0.062).	100 & 200w @ Neut (0.006). 100 & 300w @ Neut (0.041). 100 & 300w @ NO (0.021).

	Between conditions / within powers			Between powers / within conditions		
Foot/ankle kinematics	Coronal	Transverse	Sagittal	Coronal	Transverse	Sagittal
Asymptomatic (n=12)	KTT & NO @200w (0.019)	KTT & Neut @100w (0.009). KTT & NO @ 100w (0.002). KTT & NO @ 300w (0.006).	KTT & Neut @ 300w (0.045).	200 & 300w @ Neut (0.047). 200 & 300w @ NO (0.015).	No sig diffs	No sig diffs

	Between conditions / within powers			Between powers / within conditions		
Foot/ankle kinematics	Coronal	Transverse	Sagittal	Coronal	Transverse	Sagittal
Symptomatic (n=8)	No sig diffs	KTT & Neut @ 100w (0.032).	Neut & NO @ 100w (0.049). Neut & NO @ 200w (0.042).	No sig diffs	No sig diffs	No sig diffs

	Between conditions / within powers			Between powers / within conditions		
Hip kinematics	Coronal	Transverse	Sagittal	Coronal	Transverse	Sagittal
Asymptomatic (n=12)	Neut & NO @100w (0.042). KTT & Neut @ 200w (0.029). Neut & NO @ 200w (0.042).	No sig diffs	KTT & NO @ 300w (0.034). Neut & NO @ 300w (0.034).	100 & 200w @ KTT (0.035). 100 & 300w @ KTT (0.042). 100 & 200w @ Neut (0.013). 100 & 200w @ NO (0.025). 100 & 300w @ NO (0.010). 200 & 300w @ NO (0.019).	No sig diffs	100 & 300w @ Neut (0.046). 200 & 300w @ Neut (0.012). 100 & 300w @ NO (0.036).

	Between conditions / within powers			Between powers / within conditions		
Hip kinematics	Coronal	Transverse	Sagittal	Coronal	Transverse	Sagittal
Symptomatic (n= 8)	Neut & NO @ 300w (0.012).	No sig diffs	No sig diffs	No sig diffs	100 & 200w @ KTT (0.005). 100 & 300w @ KTT (0.008). 100 & 200w @ Neut (0.038). 100 & 300w @ Neut (0.008). 100 & 200w @ NO (0.046). 100 & 300w @ NO (0.007).	100 & 300w @ KTT (0.004). 100 & 200w @ Neut (0.002). 100 & 300w @ Neut (0.022). 100 & 200w @ NO (0.023). 100 & 300w @ NO (0.015).

Figure 7. Kinematic significant differences – powers/conditions.

Asymptomatic (n=12) Sagittal plane knee kinematics

CONDITION	POWER								
	100 W			200 W			300 W		
	MAX	MIN	ROM	MAX	MIN	ROM	MAX	MIN	ROM
KT TAPE	117.69	34.54	83.15	117.63	33.74	83.88	117.77	33.12	84.65
SD	3.98	6.79	5.54	3.89	6.61	5.45	3.55	6.54	5.47
NEUTRAL TAPE	118.16	34.82	83.34	118.18	33.96	84.22	118.32	33.09	85.23
SD	4.21	6.83	5.38	4.38	6.89	5.03	4.54	6.66	4.84
NO TAPE	118.41	34.77	83.64	118.52	33.64	84.87	118.28	32.12	86.16
SD	4.80	6.69	4.95	4.71	6.87	5.20	4.68	7.02	5.78

Symptomatic (n=8) Sagittal plane KNEE kinematics

CONDITION	POWER								
	100 W			200 W			300 W		
	MAX	MIN	ROM	MAX	MIN	ROM	MAX	MIN	ROM
KT TAPE	117.88	33.67	84.20	117.85	33.31	84.54	117.49	32.91	84.58
SD	4.86	6.42	6.15	4.57	5.97	6.06	4.40	5.39	4.88
NEUTRAL TAPE	118.58	34.69	83.89	117.97	33.21	84.76	118.15	32.60	85.55
SD	5.14	6.51	6.59	5.33	6.99	6.19	5.57	6.51	5.62
NO TAPE	118.99	34.95	84.04	118.78	33.74	85.04	118.30	32.29	86.02
SD	5.88	7.23	6.67	5.70	7.37	6.76	5.74	6.76	6.38

Asymptomatic (n=12) Coronal plane knee kinematics

CONDITION	POWER								
	100 W			200 W			300 W		
	MAX	MIN	ROM	MAX	MIN	ROM	MAX	MIN	ROM
KT TAPE	6.22	-0.11	6.33	5.84	-0.61	6.44	5.68	-1.09	6.77
SD	5.76	6.10	2.60	5.45	6.06	2.91	5.43	5.79	2.52
NEUTRAL TAPE	6.18	-0.14	6.32	5.77	-1.07	6.84	5.82	-0.89	6.71
SD	5.71	6.22	2.19	5.17	5.91	2.72	5.26	5.51	2.44
NO TAPE	6.50	-0.42	6.92	6.14	-0.85	6.99	6.10	-0.87	6.97
SD	5.86	6.24	2.47	5.60	6.03	3.02	5.35	5.68	2.70

Symptomatic (n=8) Coronal plane KNEE kinematics

CONDITION	POWER								
	100 W			200 W			300 W		
	MAX	MIN	ROM	MAX	MIN	ROM	MAX	MIN	ROM
KT TAPE	7.91	-0.08	8.00	7.13	-0.28	7.41	7.15	-0.94	8.08
SD	8.38	10.15	3.00	8.29	9.93	3.32	8.00	9.88	3.50
NEUTRAL TAPE	8.19	0.10	8.09	7.51	-0.13	7.63	7.57	-0.80	8.37
SD	8.33	10.20	2.72	7.69	9.64	3.24	7.54	9.54	3.66
NO TAPE	8.64	0.41	8.23	8.14	0.61	7.53	7.54	-0.16	7.71
SD	8.33	9.58	2.24	8.21	9.09	2.34	7.45	8.81	2.85

Asymptomatic (n=12) Transverse plane knee kinematics

CONDITION	POWER								
	100 W			200 W			300 W		
	MAX	MIN	ROM	MAX	MIN	ROM	MAX	MIN	ROM
KT TAPE	10.96	-3.46	14.42	10.73	-3.15	13.88	10.42	-3.04	13.46
SD	5.41	4.20	7.16	4.99	4.06	6.57	4.62	4.03	6.42
NEUTRAL TAPE	11.15	-3.44	14.59	11.21	-2.67	13.89	11.09	-2.43	13.52
SD	5.46	4.51	7.43	5.60	4.14	6.89	5.23	4.16	6.92
NO TAPE	11.01	-3.38	14.39	11.11	-2.74	13.84	11.19	-2.87	14.05
SD	6.54	4.20	7.36	6.17	3.97	7.19	5.45	4.31	7.53

Symptomatic (n=8) Transverse plane KNEE kinematics

CONDITION	POWER								
	100 W			200 W			300 W		
	MAX	MIN	ROM	MAX	MIN	ROM	MAX	MIN	ROM
KT TAPE	12.58	-3.75	16.33	11.81	-3.86	15.67	11.38	-3.67	15.04
SD	7.96	6.18	8.02	7.74	6.43	7.75	7.90	6.46	7.05
NEUTRAL TAPE	12.39	-3.34	15.73	12.33	-3.34	15.67	11.72	-3.47	15.19
SD	8.26	6.77	8.93	8.92	6.57	8.24	8.80	6.80	8.09
NO TAPE	12.55	-3.24	15.79	12.74	-3.68	16.42	11.71	-3.56	15.27
SD	9.16	6.41	8.96	9.23	6.42	8.22	9.38	6.79	8.57

Figure 8. Knee kinematics (means) -Min, Max and ROM tables.

✉ **Contact email:** graham@thebodyrehab.co.uk (G. Theobald)

[1] The Body Rehab Injury Clinic, Staveley, Cumbria

[2] School of Sport, Tourism & the Outdoors, UCLan, Preston, United Kingdom

Received: 1 May 2014. Accepted: 1 June 2014.