Institution: University of Central Lancashire

Unit of Assessment: 26 - Sport and Exercise Sciences, Leisure and Tourism

Title of case study: The influence of thermal imaging on musculoskeletal problems and sports injuries

1. Summary of the impact (indicative maximum 100 words)

We have developed techniques that have helped us to determine the efficacy and safety of cheap, cost effective and beneficial cryotherapy treatments that are readily available to professionals and patients. Utilising thermal imaging cameras, we have investigated the concept of patient sub-groups and targeted intervention in musculoskeletal conditions and sports injuries. Thermal imaging has helped us to identify a 'cold' patellofemoral patient sub-group. The impact of this work is evidenced by its contribution to the International Patellofemoral Pain Research Retreats (2010; 2012) and the PRICE Guidelines (2010) for the early management of soft tissue injuries. These provide clinicians with the underpinning research on which to conduct evidence-based practice and deliver more effective treatment.

2. Underpinning research (indicative maximum 500 words)

Paradigm Change

We were the first group internationally to develop an anatomically based method to define a region of interest for post-thermal imaging analyses. We originally developed this for our innovative work exploring patient sub-groups in patellofemoral pain (PFP) at the knee. PFP is the most common overuse injury of the lower extremity, and is particularly prevalent in those who are physically active; approximately 2.5 million runners will be diagnosed with PFP in a given year. However despite being common PFP is a very difficult condition to treat successfully; a recent prospective study reported that at 5 year follow up, 80% of patients still had pain and 74% had restricted their activity levels. Clearly in the long term, the traditional multimodal management strategies currently employed for this condition are not working. In the short term the traditional multimodal approach can also be inefficient by wasting therapeutic effort and patient time in addressing factors that are not actually contributing to the patient's condition. The change in paradigm that involves identifying specific patient sub-groups means that clinicians can now provide targeted intervention for a precise problem, which leads to improved patient outcomes. Our work in this field has specifically focussed on the assessment and treatment of a 'cold' sub-group where the predominant problem relates to painful ischaemia associated with poor local circulation, which manifests clinically as a 'cold' knee. Our work in the field of sub-grouping and targeted intervention is recognised by our significant contributions to the International Patellofemoral Pain Research Retreats (2010; 2012).

Efficacy and Safety

We have also used our anatomically based method to define a region of interest for post- thermal imaging analyses to investigate skin temperature response to a variety of low cost localised

cryotherapy interventions such as Frozen Peas and Gel Packs which patients and health care professionals can apply in domestic environments. We have also investigated more specialised clinically oriented local cooling systems such as CryoCuff and Arctic Flow. In particular we have been interested in assessing efficacy i.e. whether any of these cooling modalities actually reduce skin temperature by a therapeutically useful amount. Significantly, we found that Gel packs were actually capable of producing an excess of cooling that resulted in a transient superficial skin burn. This work on the efficacy and safety of local cooling systems has been referenced in the PRICE Guidelines (2010): Guidelines for the management of soft tissue (musculoskeletal) injury with Protection, Rest, Ice, Compression and Elevation (PRICE) during the first 72 hours. This guideline was originally published in 1998 and is highly respected and used by clinicians around the world. This first revision of the guideline in 2010 represents a significant advance on the original as it summarises evidence from over 250 high quality research studies and provides new research to underpin the conservative management of acute soft tissue injury.

3. References to the research (indicative maximum of six references)

1. Selfe J, Sutton C, Hardaker N, Greenhalgh S, Karki A, Dey P (2010) Anterior knee pain and cold knees: a possible association in women. The Knee. 17; 319-323.
2. Selfe J, Hardaker N, Whittaker J, Hayes C (2009) The efficiency of 3 cryotherapy modalities Thermology International 19 (4) 121-126
3. Kennet J, Hardaker J, Hobbs S, Selfe J (2007) A comparison of four cryotherapeutic modalities on skin temperature reduction in the healthy ankle. Journal of Athletic Training 42 (3) 343-348
4. Selfe J, Hardaker N, Whittaker J, Hayes C (2007) Ice burn to the knee: A case report Physical Therapy in Sport 8 (3) 153-158
5. Selfe J, Hardaker N, Thewlis D, Karki A (2006) A valid and reliable method of data analysis in thermal imaging of the anterior knee. Archives of Physical and Rehabilitation Medicine 87 (12) 1630-1635
6. Selfe, J Harper L, Pedersen I, Breen-Turner J, Waring J, Stevens D. (2003) Cold legs: An indicator of negative outcome in the rehabilitation of patients with patellofemoral pain syndrome? The Knee 10 (2) 139-143

4. Details of the impact (indicative maximum 750 words)

The reach and significance of the impacts we have achieved via our research lies in the applied clinical nature of the work and is firmly rooted in the every-day world of clinical practice. The focus of the research has always been to be producing results that are patient focused and clinically useful. We have challenged existing clinical paradigms and helped to optimise clinical practice by focussing on previously unrecognised clinically important factors associated with local circulatory disturbance. This has improved the health and well-being of patients attending clinics for conservative management of sports injuries and general musculoskeletal conditions. Our

publication strategy has targeted journals that are credible academically and also widely accessed and read by clinical colleagues from a diverse variety of health and sports professions. We have also significantly impacted on clinical practice internationally through our Continuing Professional Development (CPD) activities that have highlighted to practitioners the importance of circulatory disturbance and the use of cooling products. Since 2006 our group has been invited to deliver in excess of 30 keynote lectures and CPD sessions throughout the UK and Scandinavia (Finland, Denmark, Sweden) on the assessment of the 'cold' sub-group of patellofemoral patients and on the results of our "efficacy of cryotherapy" studies. These sessions cover a broad spectrum of health and sports practitioners and locations from Rehabilitation Centres in rural Finland through to the English Institute of Sport in Manchester. We have also built in local public-engagement activities. For example, we have demonstrated some of our thermal-imaging techniques and presented our scientific results to over 2,000 school children and members of the public at the 2010 & 2011 Lancashire Science Festivals. In addition we have also used the thermal imaging camera as part of an outdoor public display at the January 2011 Charity 'Firewalk'. One of the key drivers that motivates my research work is in understanding the 'Real World of Clinical Practice' and informing practitioners and the public about that work.

We have taken a significant leading role in both of the International Patellofemoral Pain Research Retreats (2010; 2012) and will be co-hosting/organising the next retreat in 2015. The mission of these International Research Retreats was to bring together scientists and clinicians from around the world who were conducting research aimed at understanding the factors that contribute to the development and, consequently, the treatment of PFP. We contributed a number of formal presentations of our research at each of the Consensus Conferences and we were also active participants in developing the consensus statements. The consensus statements play a significant role in guiding clinical practice around the world and have provided clinicians with a new clinical paradigm with which to assess and manage PFP. The conference proceedings and the Consensus Statements that were formulated at each conference have been published in the internationally influential Journal of Orthopaedic and Sports Physical Therapy, which is read by practitioners around the world.

In addition to our work on PFP, our studies on the efficacy and safety of Cryotherapy modalities has contributed to the development of the PRICE Guidelines (2010), in which three of our papers are cited. These guidelines provide detailed practical information on the clinical application of PRICE and facilitate clinicians in critical reflection on the pathophysiological rationale for using PRICE. The guidelines were developed through extensive systematic review and rigorous critical appraisal of original research and consensus from an international, expert group of clinicians and academics. The executive summary of the PRICE guidelines has been distributed to all members of the Association of Chartered Physiotherapists in Sports Medicine, approximately 1,600

clinicians.

In recognition of my impact on the physiotherapy profession I was awarded a Fellowship in 2008. "*It is recommended that a Fellowship of the Chartered Society of Physiotherapy be conferred upon Professor James Selfe for his outstanding contribution to musculoskeletal physiotherapy, particularly in the field of patello-femoral pain dysfunction for which James is known internationally as a leading authority. James has proposed new theories and developed new techniques around thermal imaging and proprioception testing and his investigations into common physiotherapy modalities for patello-femoral pain has enlightened physiotherapy knowledge and more importantly has changed the clinical practice of many physiotherapists in this country and overseas."*

Our research groups reputation in the field has developed to the extent that commercial partners are now approaching us to test the safety and efficacy of their products and equipment. These include physicool (featured on Dragons Den - was successful in gaining funding); BOC (Linde) (testing optimal exposure times inside a mobile cryochamber set at -135^{o}C in collaboration with Wigan Warriors Rugby League 1st Team); Swellaway (testing the efficacy of their newly developed heating and cooling device).

5. Sources to corroborate the impact (indicative maximum of 10 references)

[1] Davies I & Powers C (2010) Patellofemoral Pain: Proximal, Distal, and Local Factors, JOSPT; 40 (3): A1-A48. doi:10.2519/jospt.2010.0302

[2] Powers C et al, (2012) Patellofemoral Pain: Proximal, Distal, and Local Factors, JOSPT; 42 (6): A1-A20. doi:10.2519/jospt.2012.0301

[3] PRICE Guidelines (2010): Association of Chartered Physiotherapists in Sports Medicine (ACPSM) Guidelines for the management of soft tissue (musculoskeletal) injury with Protection, Rest, Ice, Compression and Elevation (PRICE) during the first 72 hours.

[4] Fellowship of the Chartered Society of Physiotherapy 2008 Citation reproduced in full in *Frontline***,** The Chartered Society of Physiotherapy Magazine (2009) 4 February Volume 15 No 3 p14-15.

[5] Regularly consulted Wikipedia website on knee pain **http://en.wikipedia.org/wiki/Knee_pain#Cold-induced**

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