

Table 2.3: Summary of the papers reviewed within this chapter

Author, date, country of origin:	Population, No. of Patients : Adults/ children	Study design:	Main findings	Sensitivity & specificity	Validity
Devereaux, M. D. Parr, G. R. Lachmann, S. M. Page-Thomas, P. Hazleman, B. L. 1984 (USA)	18 Adults	Observational study	This study examined whether thermal imaging could detect stress fractures in athletes tibia and fibulas suffering injury post exercise. Thermal imaging detected all of the fractures, shown on X-ray (No.7), however thermography did report 5 false positives. Suggesting that thermography could be used to detect fractures, but it was not specific enough to distinguish between a soft tissue injury and fracture.	Sensitivity: Calculated using the results presented: 100% (95% CI: 19.29% to 100%) as all of the fractures were detected using thermography. Specificity: 58% (95% CI: 27.75% to 84.68%)	Limited discussion regarding the methodological approach used for carrying out research. This study is an old study using out dated equipment. Small sample group with no power calculation reported. No correlation with clinical examination was mentioned or studied.
DiBenedetto, M. Yoshida, M. Sharp, M. Jones, B. 2002 (USA)	30 Adults	Randomised control trial,	Thermography can detect signs of early injury in soldiers undergoing basic training. But However it does not reveal exact diagnoses, so cannot be relied upon to detect individual foot fractures. However its greatest benefit is easy follow-up to monitor severity and healing.	Not given	No randomisation stated or obvious. Convenient sample used No obvious blinding. Methodology poorly

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Gradl, G. Steinborn, M. Wizgall, I. Mittlmeier, T. Schurmann, M. 2003 (Germany)	158 Adults	RCT	<p>At the end of the observation period 18 patients (11%) were clinically identified as complex regional pain syndrome (CRPS)</p> <p>The severity of the preceding trauma and the chosen therapy did not influence the process of the disease. 16 weeks after trauma easy differentiation between normal fracture patients and CRPS I patients was possible. 8 weeks after distal radial fracture clinical evaluation showed a sensitivity of 78% and a specificity of 94%. Thermography (58%) however and bilateral radiography (33%) revealed a poor sensitivity, respectively.</p> <p>The specificity was high for radiography (91%) and again poor for thermography (66%), respectively</p>	Sensitivity 58% Specificity 66%	No method of randomisation stated. No in-depth discussion regarding methodological controls used to ensure reliability, reproducibility and accuracy of the thermal imaging process.

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Posinkovic, B. Pavlovic, M. 1989 (Croatia)	113 Adults	RCT	113 stress fractures were found in soldiers using thermal imaging, CT, plain X-rays, ultra sound and scintiphotography. Thermal imaging was superior in detecting stress fracture in the lower limb than scintiphotography and plain X-ray films.	Not calculated	No power / sample size calculation given. Study focused on treatment rather than diagnosis. Thus limited information regarding thermal imaging methodology reported.
Sherman Bruna 1987 (USA)	30 adults	Cohort study	Thermographic recordings of body temperature were performed on 30 consecutive amputees who reported stump and/or phantom limb pain. Each subject participated in between two and four recording sessions. Whenever possible, subjects came for recording sessions when their pain intensity was different from that of previous sessions. They found that a consistent inverse relationship occurred between intensity of pain and stump temperature relative to that of the intact limb for burning, throbbing, and tingling descriptions of both phantom and stump pain. Heat emanating from the limbs is an accurate reflection of near-surface blood flow. For subjects giving these descriptions of pain, tensing the limb was followed by a decrease in blood flow and an increase in pain.	Not calculated	Small study, paper written as a discussion paper no sample size or calculation given. No discussion regarding methodology or control referred to. Limited data produce no attempt to calculate sensitivity or specificity were made, limited validity.

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<p>Hosie. Wardrope. Crosby Ferguson.</p> <p>1987</p> <p>(UK)</p>	<p>50 adults</p>	<p>Cohort study</p>	<p>The purpose of this study was to compare thermal imaging with plain x-rays to assist with the diagnosis of scaphoid fractures in adults. Three false negatives were found giving a sensitivity of 77% with 7 false positives giving a specificity of 88% recording and overall accuracy of thermal imaging compared with x-rays 80% accuracy rate. If the scan was negative, the negative predictive value was demonstrated to be over 90% The authors concluded that thermal imaging may be useful as a screening tool to determine whether a scaphiod fracture was present. Their finding suggests that thermal imaging is as accurate at detecting scaphoid fractures in adult patients with ASB tenderness when compared with plain films.</p>	<p>Sensitivity 77%</p> <p>Specificity 88%</p>	<p>Old technology, poor overall accuracy recorded when compared with current thermal imaging practice.</p>
<p>Niehof, S. P. Beerthuisen, A. Huygen, F. J. Zijlstra, F. J.</p> <p>2008</p> <p>(Germany)</p>	<p>120 Adults</p>	<p>RCT</p>	<p>The validity of skin surface temperature recordings under resting conditions to discriminate between acute CRPS1 wrist fractured in patients and control wrist fractured patients with/without complaints is limited, and only useful as a supplementary diagnostic tool.</p>	<p>71%</p> <p>Specificity 64%</p>	<p>Full randomisation explained.</p> <p>Full methodological approach explained and validated against European Association of Thermology standards.</p>

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Samokhin, A. V. 2004 (Ukraine)	1283 Adults	Observational study	Good correlation between different diagnostic procedures as computer-aided tomography, magneto-resonant tomography, magneto-resonant angiography, distant infrared thermography, laser correlation spectroscopy, scintillography, was noted in patients with proximal femoral fracture. The researcher deduced that thermal imaging could be used to identify fractures in patients with femoral fractures with good effect by recording a greater temperature recording in the affected limb when compared with the unaffected limb.	Not calculated	No Sensitivity or specificity data produced. No randomisation. Research conducted in out patients facility, Selection bias as diagnosis already known.
Silva, S.T Naveed, N Bokhari, S. Baker,K. Staib,L.H. Ibrahim,S. Muchantef,K. Goodman.T.R 2012	51 children	Pilot study	The study assessed whether digital infrared thermal images (DITI) could be used to detect extremity trauma in children. Over a 2-month period 51 children were enrolled. The warmest area of each image was compared to the site of the pain and or fracture. The digital infrared thermal imaging matched 73% of the pain sites. Fractures were seen in 11 patients. The DITI matched 7 of 11 (64%) of the fracture sites. DTTI performance for pinpointing the site of injury although suboptimal was encouraging for further evaluation.	Sensitivity 63% (95% CI: 30.88% to 88.85%) Specificity 57% (95%CI: 46.45% to 68.30%)	No attempts to control extraneous variables in regards to thermal imaging methodology or image capture.

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Birklein F, Schmelz M, Schifter S, Weber M. (2001) Germany	20 Adults	Cohort study of patients post distal radial fractures	The purpose of this study was to determine whether thermal imaging could be used to detect abnormal pathology in patient's wrists following a traumatic injury. This study's results suggest that thermography can be used to detect abnormalities in injured limbs, however the author highlighted that the temperature difference between a normal healing fracture and that of a patient with Chronic regional pain syndrome was limited.	Not calculated however power calculations and significance levels reported in study.	Research not primarily conducted to examine fracture diagnosis. No sensitivity or specificity data given. No randomisation or blinding