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Infrared Thermal Imaging as an Outcome Measure in Low Back Pain.

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ABSTRACT

To find out the role of infrared thermal imaging as an outcome measure in physiotherapy based intervention in low back pain. After obtaining informed consent**,** seventeen participants clinically and radiologically diagnosed with low back pain were included in the study. After baseline assessment for pain and tissue temperature using thermal imaging, all the participants were given interferential therapy at a frequency of 90Hz for 15mins & Low Level Laser Therapy with dose of 3.1 j/cm2(8 minutes) for low back pain. Pain assessment was done using the Visual Analog Scale (VAS), Facial Pain Scale (FPS). All participants received treatment for ten days and at the end of the last session all the subjects were re-evaluated for pain and tissue temperature. Both outcome measures were analysed by paired t test. Level of significance was kept at $p<0.05$. The analysis showed significant reduction in tissue temperature and pain in all participants. VAS score was significantly reduced from 6.71±2.114 to 4.06±1.853 ($p<0.001$) and FPS was reduced from 4.82±1.01 to 2.71±1.16 ($p=0.001$). Temperature was significantly reduced from 32.35±2.44 degree Celsius to 29.91±2.48 degree Celsius ($p=0.002$) In the present study, we found that, Infrared thermal imaging can be objectively used as an outcome measure in the treatment of low back pain.

Keywords: Thermography, temperature mapping, low back pain, visual analogue scale.

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INTRODUCTION

Low Back Pain (LBP) is the most common reason for the general population to consult health care professionals and has high prevalence rates between 50% and 76% [1, 2, 3]. The causes of low back pain can be very complex, and there are many structures in the spine that can cause pain. Among all primary care patients with low back pain, less than 5 percent will have serious systemic pathology. Although patients are often told a specific diagnosis for their back pain, reproducibility of these diagnoses (i.e., muscle spasm, sacroiliac pain, and trigger points) among providers is poor [5, 6]. Not all the patients are diagnosed with structural changes in the spine which leads to low back pain. But most of the patient's diagnosis appears normal on X-ray, CT or MRI even though pain persists. During these situations it is really very important to understand cause for the pain and how the management is effective.

Diagnosing low back pain is based on symptoms, clinical tests and advanced techniques like CT, MRI which are found to be very useful when the back pain is due to structural changes at the spinal level [7]. These techniques are considered to be time consuming and expensive for the general population. However, diagnosing back pain due to unknown origin is dependent on clinical tests, a standard outcome measure is very essential to quantify condition. It is well known that pain is always associated with increased local temperature and to quantify the temperature several outcome measures have been used where Infrared thermal Imaging is considered to be the most advanced outcome tool.

During the last few decades, Thermography also known as Thermal imaging has been widely used in various industrial applications to detect, monitor and predict regulations in many fields from engineering to medical and biological observations [8]. In medical field, body temperature is used as a one of the diagnostic parameters for diagnosing diseases. It is also well known that there is a definite correlation between the body temperature and diseases. Human body temperature has been recorded with thermocouples, thermistors and thermopiles for almost 60 years and these are large in size, slow in response and time consuming [9]. Technology with advanced and portable devices have come into existence to record skin temperature. Digital technology makes diagnosis of diseases simple and easy through digital infrared thermal imaging.

The human body is an efficient thermal system; we are dependent on the ability of the body to regulate human body temperature. One of the key factors in thermoregulation of the human body is the skin which is the dynamic interface between the body and environment. Human skin has an emissivity of 0.98 which is almost equal to black body radiator, where temperature changes on the skin surface can be well detected by thermal imaging techniques [10, 11].

Infrared thermal imaging is a non-conduct and non-invasive diagnostic tool that allows a health care provider to see and measure the changes in the skin surface temperature. First uses were made in the 1960's with large and noisy infrared thermal cameras. These were used in some research studies and applied to the non-invasive study of the human skin temperature [12]. Thermal imaging has been widely used in the medical field in neurology, oncology, orthopaedics and dermatology [13, 14]. This technique was more widely used in the studies on breast cancer [15-17]. In oncology, tumours are characterized by increased gradients compared to other surrounding tissue; [18], while in plastic surgery, infrared thermal camera can evaluate the reperfusion of perforator flaps [19]. But in physiotherapy, the progress of the low back pain subjects are completely based on the symptoms of the patient. Even though, Physiotherapy has been commonly used in the management of patients with back pain with no structural changes in the spine [20]. This typically involves a variety of interventions, but commonly involves exercise, advice, Maitland mobilization, the McKenzie method, abdominal exercises, pulsed short-wave diathermy, interferential therapy, ultrasound as well as numerous other less commonly used interventions [21-25].

It is clear from these surveys that physiotherapy interventions are very effective. But this effectiveness is completely dependent on symptoms of the patient and cannot be quantifiable. Understanding this, we hypothesize that Infrared thermal imaging can be a very useful outcome tool to measure the low back pain at initial stages. Therefore, the objective of the present study was to describe the role of infrared thermal imaging as a productive outcome measure tool in the subjects with low back pain.

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METHODS

The present study was an experimental study approved by the Institutional Ethical Committee (IEC) in which after obtaining written informed consent, seventeen subjects who had clinical symptoms of low back pain with or without radiating pain were included in the study. Subjects with history of fracture or surgery on the spine or legs, inflammatory skin lesions, peripheral polyneuropathy and psychologically unstable patients were excluded. Baseline clinical evaluation was done followed by infrared thermal imaging. All the subjects received interferential therapy at a frequency of 90Hz for 15mins & Low Level Laser Therapy with dose of 3.1 j/cm2 (8 minutes) every day for their low back pain. Pain assessment was done using the Visual Analog Scale (VAS), Facial Pain Scale (FPS).

Infrared thermal imaging (Figure 1) was done using infrared thermal camera (GUIDE ® EASIR-4, Wuhan Guide Infrared Co., Ltd., China) with sensitivities of 0.08 and 0.010C, a temperature range between -200C to 2500C. The subjects were acclimated for 15 minutes in the examination room by lying on examination table with test site exposed. Infrared thermal imaging (Figure 1) was recorded at baseline followed by physical therapy treatment for 1 session per day for 10 days, and at the end of the last session all the subjects were re-evaluated.

Figure 1

RESULTS

In the present study, a total of 17 subjects (8 males and 9 females) were included with a mean age of 46.88 ± 13.00 years (Table1). VAS score was significantly reduced from 6.71±2.114 to 4.06±1.853 ($p<0.001$) and FPS was reduced from 4.82±1.01 to 2.71±1.16 ($p=0.001$). Temperature was significantly reduced from 32.35±2.44 degree Celsius to 29.91±2.48 degree Celsius ($p=0.002$). (Table 2).

Table 1: Demographic Characteristics

Age (Years)	46.88±13.009
Gender	Males:8 Females:9

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Table 2: Comparison of pre and post characteristics of subjects in the group

	pre	post	p value
FPS	4.82±1.01	2.71±1.16	0.001
VAS	6.71±2.114	4.06±1.853	< 0.001
Thermal Imaging (Degree Celsius)	32.35±2.44	29.91±2.48	0.002

VAS: Visual Analog Scale, FPS: Facial Pain Scale

DISCUSSION

Skin is a dynamic membrane regulating the interaction between the body and its environment, and is crucial for the regulation of the body temperature [10]. The elevated skin temperature has always been indicator of dysfunction, where increased heat is mainly associated with some sort of inflammation or infection [17] and can be detected easily using infrared thermography in the clinical setting. A considerable number of studies have sought to determine the relationship between skin temperature and low back pain [18]. In the present study we found significant decrease in pain (VAS and FPS scale) and also reduction in temperature which was assessed using infrared thermal imaging. Therefore, Infrared thermal imaging and analysis is an outstanding technology that allows non-contact, non-invasive investigation of biological systems, both in preclinical research settings and in the clinical assessment of patients.

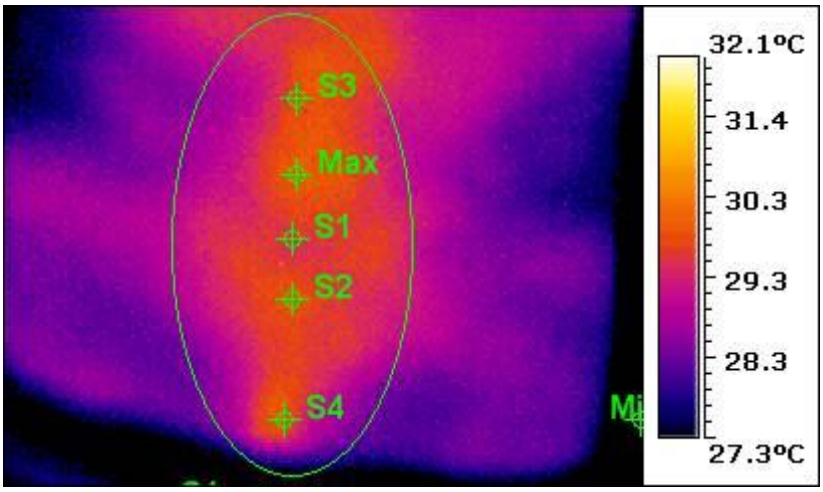

Figure 2

Low back pain is accompanied by local inflammation which leads to increase in the local tissue temperature (Figure 2). In the study we found that physical therapy based pain management decreased the objective measures of pain like Visual Analog Scale and the Fascial Pain Scale. It was very interesting to note that correlating with the decrease in pain the local thermal temperature seen through thermal imaging also decreased. This helps us understand that thermal imaging can be a useful outcome measure tool in assessing local inflammation arising due to acute injuries or pain. The thermal camera we have used in this study is portable and user friendly. It provides a great amount of ease in detecting local tissue inflammation and hence giving a very clear objective measure of the tissue inflammation or damage. Therefore we conclude that the proper identification of hyper - and hypothermic areas by Infrared thermal imaging guides the clinician in management of pain, more accurate diagnosis, and avoidance of further trauma to the already damaged tissues. Infrared thermal imaging can be considered as one of the advanced outcome measure tool with great potential for widespread use both in different specialties of clinical and in research settings.

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