The Correlation of Thermal FLIR Imaging and Severity Score in Patients with Newly Diagnosed CRPS

FUNDER: Department of Anesthesiology

PROTOCOL NO.: 2022-2175

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PROTOCOL SYNOPSIS

Protocol Title:	The Correlation of Thermal FLIR Imaging and Severity Score in Patients with Newly Diagnosed CRPS
Protocol Number:	2022-2175
Protocol Date:	2/17/2023
Sponsor:	Department of Anesthesiology
Principal Investigator:	Semih Gungor, MD
Products:	Forward Looking Infrared (FLIR) camera
Objective:	This study aims to determine the severity of CRPS in newly diagnosed patients by using thermal camera imaging (FLIR).
Study Design:	Cross-sectional Study
Enrollment:	30
Subject Criteria:	Inclusion: • The patient is between 18 and 85 years old • Providing CRPS diagnostic criteria by using Budapest Clinical criteria • The patient is affected with CRPS in a unilateral limb • The patient has had pain and other symptoms for more than 3 months. Exclusion: • Patients with suspected disc herniation, spinal stenosis, myelopathy, and suspected radiculopathy in detailed examinations and examinations (MRI, CT) • Systemic or local infection • Malignancy • Pregnancy • Uncontrollable medical and psychiatric condition • Patients diagnosed with dysautonomia, sympathetic dysfunction (such as Raynaud disease or Buerger disease), sweating disorders (such as acquired idiopathic generalized anhidrosis), and patients on vasoactive drugs, the mechanism of action is directly on the vascular tone
Study Duration:	1 year
Data Collection:	**Sources:** EPIC, Medical Records, and Patient Reported. **Variables:** Name, MRN, DOB, Race, Ethnicity, Gender, Height, Weight, BMI, ASA class, email address, phone number, co-morbidities (diabetes, high blood pressure, cholesterol, rheumatological conditions, allergies), medications to manage pre-existing conditions (opioids and non-opioids), surgery details (surgeon, anesthesiologist, surgery type, tourniquet use, duration), anesthesia details, NRS pain scores, nerve block success, duration of block.

Statistical Analysis:	1. **Proposed analysis (e.g., student's t-test, ANOVA, chi-square, regression, etc.):** We will rely on students t-test when comparing pairs of groups and ANOVA when comparing multiple groups; regression will be used to assess strength of relationship between NRS and objective diffusion metrics. **2. Interim analysis planned?:** No 3. **Alpha level:** 0.05 4. **Beta or power level:** 0.2 5. **Primary outcome variable estimate (mean +/- s.d. for continuous outcome, frequency/percentage for categorical variable):** 6. **Number of groups being compared (use 1 for paired analysis within the same subjects):** 1 7. **Effect size or change expected between groups:** 8. **Resulting number per group:** 30 9. **Total sample size required:** 30

1.0 INTRODUCTION

CRPS can present with sympathetically maintained pain in an extremity after an injury. In sympathetically maintained pain, physiologic activation of cutaneous vasoconstrictor neurons projecting to the painful limb enhances spontaneous pain and hyperalgesia [2]. It has been postulated that there is pathological interaction between sympathetic and afferent neurons within the skin. For the diagnosis of CRPS, international criteria, “Budapest Criteria,” has been used. However, this diagnostic Budapest Criteria does not give information about the severity of CRPS. Therefore, a severity score named ‘CRPS Severity Score (CSS)’ was derived and validated). CSS depends on the presence/absence of 17 clinically characteristic signs and symptoms for dichotomous (yes/no) [6]. Based on the presence/absence of these 17 clinically assessed signs and symptoms of CRPS, a CRPS Severity Score (CSS) can be assigned. Higher CSS was associated with significantly higher clinical pain intensity, distress, and functional impairments, as well as more significant bilateral temperature asymmetry and thermal perception abnormalities [5].

In CRPS, the abnormalities are thought to be either caused by hyperactivity or hypoactivity in sympathetic vasoconstrictor and sudomotor neurons on the affected side. Existing studies showed that skin temperature asymmetry between the affected and contralateral extremities around 0.6-2 °C is useful for diagnosing CRPS [2,3,7]. Bruehl et al. suggested that thermography can be a valuable component for a diagnosis, and a 0.8-1.0°C temperature difference may be considered for the diagnosis of CRPS [2]. Wasner et al. [8] showed that a maximal skin temperature side difference of more than 2.2 °C during changes in the environmental temperature using a thermal suit is highly sensitive and specific for distinguishing CRPS from other extremity pain syndromes. The diminished blood flow may be caused by either sympathetic dysfunction, hypersensitivity to circulating catecholamines, or endothelial dysfunction [3]. The diminished blood will lead to significant temperature asymmetry and thermal perception abnormalities, demonstrating a positive correlation with higher CSS.

One publication studied the correlations between the ΔT, pain score, and CSS [4]. In this study, investigators used direct skin temperature measurements and did not use FLIRR images for comparison. According to this study, the ΔT did not correlate with pain score or with CSS in CRPS patients. There has been no similar study utilizing FLIRR images. As we discussed before, determining the severity of the disease in the early period is important for planning proper treatment to prevent disease progression. This study aims to evaluate whether there is any correlation between the skin temperature asymmetry measured by FLIRR images and pain score (NRS) and CSS in the early period of the disease.

2.0 OBJECTIVE OF CLINICAL STUDY

CRPS patients have an increased chance of remission with treatment in the early period of the disease. Similarly, determining the severity of the disease in the early period is important for planning appropriate treatment to prevent progression. The lack of an objective method for understanding the severity and possible progression of CRPS is a critical reason for delayed CRPS treatment. If infrared (FLIR) imaging can be used for determining the severity of CRPS in newly diagnosed patients and if any correlation is shown between the quantification of ‘the Δ heat index value’ measured by FLIR imaging and the severity score for CRPS in newly diagnosed patients, this result of this research can be helpful in daily clinical practice.

3.0 STUDY HYPOTHESES

Evaluation of the temperature difference between the normal limb and affected limb with Infrared (FLIR) images obtained by a thermal camera can be used as objective criteria to evaluate the severity of CRPS in newly diagnosed CRPS patients.

In more detail, the hypotheses of the project can be listed as follows:

- **Hypothesis 1:** When comparing the FLIR images difference between the normal limb and CRPS affected limb, there will be significant differences in the temperature of two extremities due to CRPS-related dysfunction in circulation and perfusion.
- **Hypothesis 2:** Infrared FLIR camera is a more reliable and rapid method for determining the severity of CRPS in newly diagnosed patients.
- **Hypothesis 3:** When a significant difference in temperature between two extremities caused by perfusion problems is observed, this change (the Δ heat index value) will be correlated with the pain level (delta pain NRS value) and CRPS severity; this will enable quantification of the correlation between the temperature difference and the NRS/severity score in CRPS patients.

4.0 STUDY DESIGN

4.1 Study Duration

February 2023 – February 2024

4.2 Endpoints

4.2.1 Primary Endpoint

- In newly diagnosed patients, the severity score of CRPS will be higher in the presence of a higher Δ heat index value.

4.2.2 Secondary Endpoints

- In newly diagnosed patients, the NRS will be higher in the presence of a higher Δ heat index value.

4.3 Study Sites

This study will take place at the 75th St campus of the Hospital for Special Surgery (HSS).

5.0 STUDY POPULATION

5.1 Number of Subjects

30

5.2 Inclusion Criteria

Subjects of either gender will be included if they:

- The patient is between 18 and 85 years old
- Providing CRPS diagnostic criteria by using Budapest Clinical criteria
- The patient is affected with CRPS in a unilateral limb
- The patient has had pain and other symptoms for more than 3 months

5.3 Exclusion Criteria

Subjects will be excluded from the study if they:

- Patients with suspected disc herniation, spinal stenosis, myelopathy, and suspected radiculopathy in detailed examinations and examinations (MRI, CT)
- Systemic or local infection
- Malignancy
- Pregnancy
- Uncontrollable medical and psychiatric condition
- Patients diagnosed with dysautonomia, sympathetic dysfunction (such as Raynaud disease or Buerger disease), sweating disorders (such as acquired idiopathic generalized anhidrosis), and patients on vasoactive drugs, the mechanism of action is directly on the vascular tone

5.4 Randomization

Participants will not be randomized to multiple groups. All patients will receive the FLIR camera.

6.0 PROCEDURES

6.1 Surgical Procedure

Sympathetic nerve block

6.2 Medical Record Requirements

Using EPIC, research staff will review the patient's medical history to determine eligibility to participate in the study.

PHI that will be reviewed:

Name, DOB, preferred language, medical history, allergies, current outpatient medication, weight & body mass index

6.3 Data Collection

The following data will be collected:

Pre-operative/Baseline

Name, MRN, DOB, Race, Ethnicity, Gender, Height, Weight, BMI, ASA class, email address, phone number, medications, co-morbidities, NRS value

Surgical procedure

- Surgery details (date of surgery, surgeon, laterality, duration, tourniquet use)
- Anesthesia details (neuraxial, PNB, medications given)
- FLIR camera imaging

Follow-up visits (PACU, Discharge, Post-operative day of surgery (POD) 10, 30, 90)

- NRS value
- FLIR camera imaging

7.0 STATISTICAL ANALYSIS

Proposed analysis (e.g., student's t-test, ANOVA, chi-square, regression, etc.): We will rely on students t-test when comparing pairs of groups and ANOVA when comparing multiple groups; regression will be used to assess strength of relationship between NRS and objective diffusion metrics.
Interim analysis planned?: No
Alpha level: 0.05
Beta or power level: 0.2
Primary outcome variable estimate (mean +/- s.d. for continuous outcome, frequency/percentage for categorical variable):
Number of groups being compared (use 1 for paired analysis within the same subjects): 1
Effect size or change expected between groups:
Resulting number per group: 30
Total sample size required: 30

8.0 ADVERSE EVENT ASSESSMENT

All Adverse Events (AEs) will be reported in the final study report.

9.0 REFERENCES

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