

# The Potential Role of Thermography in Determining the Efficacy of Stroke Rehabilitation

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*Introduction:* Maintaining good physiological circulation in the extremities requires an optimally functioning muscle pump. Stroke symptoms indicate a change in venous circulation. In this study, changes were measured in joint function and microcirculation, and the correlation between them was examined. *Setting:* Physiotherapy Center, Ss. Cosmas and Damian Rehabilitation Institute, Visegrád, Hungary. *Methodology:* Sixteen randomly selected poststroke patients with hemiparesis affecting mainly the upper extremities began undergoing rehabilitation 13 ± 4 days following stroke. Thermograms were taken with a Fluke Ti 20 (Fluke Corporation, WA) pretreatment and post-treatment, and a physiotherapy documentation form was completed. Treatment comprised 15 physiotherapy, massage, and galvanic therapy sessions per patient, with the side exhibiting no neurological symptoms as a control. *Results:* Joint function showed significant improvement on the affected side ( $P < .05$ ). Thermographic examinations revealed microcirculatory dysfunction in the affected extremities in 100% of the cases. Following treatment, temperature increased significantly ( $P \geq .5^{\circ}\text{C}$ ) on the affected side. A strong correlation ( $r$ ) was observed between joint function and temperature change ( $P < .05$ ). *Conclusion:* Thermography is shown to be a reliable method for monitoring the effects of stroke rehabilitation treatment. Thermographic testing may enable us to predict the course of the trauma and the efficacy of treatment even at the acute stage. **Key Words:** Stroke—microcirculation—thermography—rehabilitation. © 2017 National Stroke Association. Published by Elsevier Inc. All rights reserved.

## Introduction

According to the Helsingborg Declaration endorsed by the European Stroke Council, stroke is one of the leading causes of disability.<sup>1</sup> Therefore, it is not surprising that there is extensive literature on the rehabilitation of stroke patients.<sup>2,3</sup> Various measures have been developed to examine the functional status, participation levels, and quality-of-life consequences of stroke.<sup>4</sup>

Among the more frequently used generic instruments are the Medical Outcomes Study 36-Item Short Form Health Survey,<sup>5</sup> Sickness Impact Profile,<sup>6</sup> Functional Independence Measure,<sup>7</sup> Frenchay Activities Index,<sup>8</sup> Nottingham Health Profile,<sup>9</sup> and Life Satisfaction Questionnaire.<sup>10</sup> In everyday practice, a so-called “physiotherapy documentation form” is used to record the effects of stroke rehabilitation.<sup>11</sup> In addition to the quality-of-life tests (Mahoney and Barthel<sup>12</sup>), this includes the Norton<sup>13</sup> scale and measures the pain reported by the patient on a visual analog scale.<sup>14</sup> The test indicates all ranges of motion in degrees before and after the rehabilitation program, making it easy to observe the changes in function in the spastic or flaccid extremity. It is a generally known physiological necessity that normal circulation in the extremities requires an effectively functioning muscle pump as well.<sup>15</sup>

Thermography has been employed for years as a diagnostic imaging system in various fields of medicine. It has been used with excellent results to diagnose medical conditions (such as renal cancer and testicular cancer)

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**Table 1.** Age distribution of patients and comorbidities

|               | Age distribution of patients |        | Comorbidities                              |
|---------------|------------------------------|--------|--|
|               | Male                         | Female |  |
| Total         | 10                           | 6      | High blood pressure (11)<br>(hypertension) |
| Age           | 45-65                        | 66-73  | Hyperlipidemia (10)                        |
| Average age   | 58                           | 70.5   | Diabetes mellitus (4)                      |
| Total average |                              | 62.68  | Coronary heart disease (3)                 |
|               |                              |        | Hyperuricemia (2)                          |

involving increased perfusion.<sup>16</sup> Some authors have compared the use of magnetic resonance imaging, computed tomography (CT), myelography, and thermography in lower back pain.<sup>17</sup> Other authors have compared lumbar spine thermography with the CT scan.<sup>18</sup> In earlier work, my colleagues and I have used thermography effectively in measuring the effects of laser therapy in extension treatment of the neck.<sup>19,20</sup> A comparative evaluation of the effectiveness of Doppler ultrasonography and angiography has been undertaken in patients with Fontaine stages II-III atherosclerosis obliterans. The thermographic method has provided invaluable information in assessing the development of the compensatory collateral vascular system. For patients with increased infrared emission in vascular occlusion, conservative therapy has proved to be significantly more effective. Tests suggest that thermography could be used not only in diagnosis but in prognosis as well.<sup>21</sup>

### Objective

The objective was to measure the changes in joint function and microcirculation and to examine the correlation between them. Based on the findings, the aim was to determine the extent to which thermography may be effective in stroke rehabilitation.

### Patients and Methodology

The participants were 16 randomly selected ischemic stroke patients (10 males and 6 females; average age: 62.68 years) with hemiparesis affecting mainly the upper extremities; the rehabilitation program was started  $13 \pm 4$  days following stroke.

The following comorbidities were identified: high blood pressure (hypertension) (11), hyperlipidemia (10), diabetes mellitus (4), coronary heart disease (3), and hyperuricemia (2) (Table 1).

A cranial CT scan performed in the acute stage invariably showed ischemic damage, while carotid ultrasonography indicated significant clogging and circulatory dysfunction in 10 patients (Table 2).

A physiotherapy documentation form was completed before and after treatment, and thermograms were taken of the extremities using a Fluke Ti 20 camera (Fluke Corporation, WA).

In order to express the functioning of the joint using a single parameter that best represents the functioning of the joint and at the same time can be used well in mathematical analysis, a so-called "global joint function" was developed. Calculations were made to arrive at a percentage of the maximum range of motion for the value measured for every single joint and for all ranges of motion. These values were added up, the average was calculated, and the value was obtained as a percentage.

During the thermographic examination, it was assumed that if the ambient temperature is below 30°C and the patients are relaxed, they will release heat in the form of radiation and not perspiration. Therefore, if external temperature was adjusted such that neither perspiration nor vasodilatation interfered in heat release, infrared radiation emitted from the skin would depend solely on internal factors, that is, metabolism, and consequently on circulatory conditions and blood supply.

Considering that thermographic examination is very sensitive but its specificity is low, an effort was made to create appropriate standardized conditions. This meant

**Table 2.** Results from cranial CT scans and carotid USG examinations performed in the acute stage

| Cranial CT scan (ischemia) |    | Carotid USG (atherosclerosis + circulatory dysfunction) |          |
|----------------------------|----|---|----------|
|                            |    | Positive  | Negative |
| Male                       | 10 | 7   | 3        |
| Female                     | 6  | 3   | 3        |

Abbreviations: CT, computed tomography; USG, ultrasonography.

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