

Forehead-Back Thermal Ratio for the Interpretation of Infrared Imaging of Spinal Cord Lesions and Other Neurological Disorders

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●In 98 volunteers and 63 patients with neurological disorders, including syringomyelia and spinal cord tumor, mean temperatures and the ratio between forehead and upper and middle back temperatures were determined thermographically. Analysis showed that the mean temperatures of the upper and middle back and the mean values of the forehead to upper and middle back ratios were higher in patients than in volunteers. In many cases the mean temperatures and the forehead-back ratios deviated from the normal range. Forehead-back ratio was more sensitive in detecting thermal abnormality than was the temperature of the back. Most cases with abnormal temperature of the forehead and back also showed an abnormal forehead to upper back ratio. Forty-four (69.8%) of 63 patients showed abnormal upper-and/or middle-back ratio. Ten (22.7%) of 44 patients showed both no thermal asymmetries and abnormal longitudinal thermal gradient of the back. The forehead-back ratio is one quantitative method for determining the thermal gradient of the back and a useful complementary method for interpreting the infrared imaging of patients with spinal cord lesions and other neurological disorders.

Abnormal thermal asymmetries of the back in excess of 0.3C are reliable landmarks for diagnosing thermal dysfunction in spinal cord lesions^{1,2} and other neurological disorders with autonomic dysfunction.³ However, in some cases with hemilateral spinal cord involvement the temperature difference can be less than 0.3C. In addition, bilateral involvement of the spinal cord may result in cutaneous temperatures that, although abnormal, are bilaterally symmetrical. In such cases a longitudinal thermal gradient of the back may be helpful. In our previous report² a comparison of longitudinal thermal gradients between patients and volunteers was done. When the temperature curve of a patient deviated from the normal patterns, it was judged to be abnormal. However, the previous report left some questions to be resolved regarding more quantitative methods and the

setting of the reference site. To answer these questions, this paper reports the comparison of the forehead-back thermal ratio between volunteers and patients with spinal cord lesions, degenerative disease, or other neurological disorders and discusses the usefulness of the forehead-back thermal ratio for interpretation of infrared imaging.

Materials and Methods

Infrared imaging of the face, trunk, and extremities was performed on 98 normal, asymptomatic volunteers and 63 patients, 18 with syringomyelia, 9 with spinal cord tumor, and 22 with degenerative disease of the nervous system [including 9 with spinocerebellar degeneration (SCD), 2 with Joseph disease, 7 with Shy-Drager syndrome, 3 with olivopontocerebellar atrophy (OPCA), 1 with striatonigral degeneration (SND)], and 14 with miscellaneous neurological disorders, including spinal cord atrophy. Syringes, tumors, cerebellar atrophy, and cord atrophy were confirmed by X-ray, CT, and/or magnetic resonance imaging. All of the tumors and some of the syringes were also confirmed by surgery. Infrared imaging* was performed after 20 minutes of equilibration in a draft-free laboratory that was maintained at 25C. Evaluation of thermal asymmetry and abnormal longitudinal thermal gradient of the back was performed by the method reported previously.² In addition, ROIs were set on the hemilateral forehead and on the ipsilateral upper one-third ("upper back") and middle one-third ("middle back") of the back between the first thoracic and fourth lumbar vertebrae. The mean temperatures in ROIs and the ratio of the mean temperatures of the upper and middle back to that of the forehead (forehead to upper and middle back ratio) were determined and comparison of the values between patients and volunteers was performed with quantitative analyses, including discriminant analysis.⁴

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* Thermal Video System 4300, Nippon Avionics Ltd., Tokyo.