

# COMPARISON OF PARASPINAL CUTANEOUS TEMPERATURE MEASUREMENTS BETWEEN SUBJECTS WITH AND WITHOUT CHRONIC LOW BACK PAIN

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## ABSTRACT

**Objective:** The purpose of this study was to evaluate the effects of chiropractic manipulative treatment on paraspinal cutaneous temperature (PCT) for subjects with chronic low back pain and compare these PCT findings to subjects without chronic low back pain.

**Methods:** Two groups were created, a symptomatic treatment group (subjects with chronic low back pain, n = 11, 7 males, 4 females) and an asymptomatic, nontreatment group (asymptomatic subjects, n = 10, 6 males, 4 females). Outcomes included the modified Oswestry questionnaire and PCT measurements in the prone position after an 8-minute acclimation period. The treatment group received 9 chiropractic spinal instrument-based manipulative treatments over 2 weeks. Reevaluation was done 2 weeks after the initial evaluation for both groups.

**Results:** The preintervention Oswestry results ( $29.8\% \pm 11.8\%$ ) for the treatment group were higher than the asymptomatic group ( $10.2\% \pm 10.6\%$ ). The postintervention Oswestry results for the treatment group were  $14.20\% \pm 11.5\%$ . The resulting Cohen's effect size of the spinal manipulation on the Oswestry evaluation is 0.58. The preintervention PCT showed higher temperature for the nontreatment group compared with the treatment group. Comparing the levels associated with low back pain, the nontreatment group PCT was stable, varying from  $0.01^\circ\text{C}$  to  $0.02^\circ\text{C}$ , whereas the treatment group PCT varied from  $0.10^\circ\text{C}$  to  $0.18^\circ\text{C}$ . The treatment group postintervention PCT showed an increase in temperature after the 9 visits; however, this did not reach the values of the asymptomatic group.

**Conclusion:** The PCT readings for subjects with chronic low back pain were lower than the asymptomatic, nontreatment group. The PCT temperature of the treatment group increased after 9 treatments. (*J Manipulative Physiol Ther* 2013;36:44-50)

**Key Indexing Terms:** *Diagnostic Techniques and Procedures; Thermography; Low Back Pain; Chiropractic*

The chiropractic profession has investigated different outcome measures as a means of monitoring chiropractic care<sup>1-9</sup>; the Oswestry disability index is one of these tools used to evaluate the activities of daily living for patients with low back pain.<sup>10,11</sup> Recently,

paraspinal cutaneous temperature (PCT) has been evaluated by Owens et al,<sup>4</sup> and they noted that intraexaminer and interexaminer reliability of paraspinal thermal scans were found to be very high, with intraclass correlation coefficient values between 0.91 and 0.98. Recent research<sup>12</sup> showed that an 8-minute period is recommended as the optimal period in an acclimatized temperature- and humidity-controlled environment, followed by an 8-minute maximum recording period with the patient in a prone position to obtain valid PCT recordings.

Two studies<sup>7,9</sup> on the effect of a manipulation on PCT revealed that the PCT actually increased after a spinal manipulation. It was demonstrated that there is a difference in obtaining PCT recordings when patients are prone or standing,<sup>13</sup> with the PCT being warmer in the group standing. It was also shown that the hand leaves the area that was manipulated as a warmer area immediately after the chiropractic manipulation with the hand, and this effect lasted up to 2 minutes.

Holey et al<sup>14</sup> demonstrated that using thermography from 1 m away from the subject that, in healthy subjects, connective massage had an effect on a point localized

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between the iliac crest and the posterior superior iliac spine. We demonstrated in the past the effect of 1 manipulation<sup>7,9</sup> on PCT in acute cases. Our technology is within 1 cm from the subject, and we realize that we are mentioning 2 different approaches to the same technology. It still presents the possibilities that direct contact may affect the PCT. The measurements of interest were taken at 15 minutes (end of the first window of opportunities to record stable temperature<sup>12</sup>) and 30 minutes (beginning of the second window of opportunities to record stable temperature<sup>12</sup>). Paraspinal cutaneous temperature was also evaluated via thermography by Wu et al<sup>15</sup>; their results indicate that the PCT decreased after 12 weeks of treatment. However, they did not use the recommended period for the participant adaptation to the room temperature. Their window started at 15 minutes just when we reach the end of the stable recording period, the PCT starts to destabilize,<sup>12,14</sup> so we regard their results with caution.

Several authors offer physiologic explanations to explain PCT modifications.<sup>16</sup> Uematsu et al<sup>17</sup> states that “Skin temperature, a function of superficial perfusion controlled by the sympathetic vasoconstrictor nerves. An increased sympathetic excitation a reflection of nerve root irritation may cause active vasoconstriction, resulting in decreased skin temperature.” Korr<sup>18</sup> researched the concept of segmental facilitation that may cause vasoconstriction of the arterioles in the skin.

Uematsu<sup>19</sup> reported that, in asymptomatic participants, the average skin temperature difference between sides of the body was only  $0.24^{\circ}\text{C} \pm 0.073^{\circ}\text{C}$ . In contrast, in patients with peripheral nerve injury, the temperature of the skin innervated by the damaged nerve was colder and was decreased by an average of  $1.55^{\circ}\text{C}$  ( $P < .001$ ). Uematsu<sup>19</sup> proposes that “because of the complexity of the normal skin temperature pattern and possible anatomical variations, the sensory examination and thermography imaging should be evaluated in conjunction with good clinical judgment. It should be noted that skin temperature may change as the sympathetic nerve recovers.”

The increased temperature of PCT after chiropractic manipulation has been a point of contention. It is not known if the warming created by an inflammation process results from the manipulation, a physiological reaction to the mechanical pressure, a neurological reflex reaction, or a renewed muscular activity resulting in a return to normal PCT.

Acute low back pain was investigated with PCT measurement<sup>7,9</sup>; it was found that the side of injury could be warmer or colder depending on the window at which the measurement was made,<sup>7</sup> but the side of acute injury was warmer in the other study.<sup>9</sup> If there are differences between the results of a previous study<sup>9</sup> on acute participants and this study with chronic participants, we may begin to investigate different treatment approaches for the different types of treatment and supportive care of people with low back pain.

**Table 1.** Anthropometric characteristics of the subjects (mean  $\pm$  SD)

Variables	Nontreatment group	Treatment group
Weight (kg)	74.9 $\pm$ 16.9	80.3 $\pm$ 16.5
Height (m)	1.7 $\pm$ 0.1	1.7 $\pm$ 0.1
BMI	25.3 $\pm$ 3.6	28.0 $\pm$ 3.7
Sex	6 (M), 4 (F)	7 (M), 4 (F)
Age (y)	47.5 $\pm$ 16.2	45.6 $\pm$ 8.9

BMI, body mass index; M, male; F, female.

Except for those previously mentioned studies,<sup>7,9</sup> it is unknown what PCT measurement represents in relation to individuals with and without pain. Therefore, the purpose of this study is to compare PCT recordings between asymptomatic participants and participants with chronic low back pain who are treated with chiropractic manipulation over a 2-week period.

## METHODS

### Participants

The required number of subjects was established by using the Cohen<sup>20,21</sup> formulas on effect size.<sup>7,9,17</sup> The resulting minimum number of required subjects was determined to be 6 per group. Therefore, a total of at least 10 subjects per group were recruited to control for attrition so that, at the end of the study, at least 6 participants would remain. Anthropometric characteristics of the participants are shown in Table 1. The research protocol for this study was approved by the Université du Québec à Montréal ethics committee. Written informed consent was obtained from all participants. This study was registered with clinicaltrials.gov, registration number NCT00739570. All participants completed the Oswestry questionnaire, the side of pain was noted, and the PCT measurements were obtained. The side of treatment is noted as the pelvic deficiency (PD) side and the side opposite is noted as nonpelvic deficiency (NPD).

**Nontreatment Group.** A total of 10 participants were recruited, 4 females and 6 males at the beginning of June 2008 from a chiropractic clinic, located in LaSalle, Quebec. The inclusion criterion was that all participants in the nontreatment group were pain free. All participants were evaluated for all the same outcome measures as the treatment group.

**Treatment Group.** All treatment group participants were recruited through a newspaper advertisement in “Le Messenger de LaSalle” taken during the period from July 6 to 20, 2008. Forty-five subjects responded to the advertisement. The inclusion criterion was the presence of a chronic low back condition of at least 3 months in duration and they had never received chiropractic care for this condition. The 11 participants who met this inclusion criterion, 4 females and 7 males, were included in the study.

### Chiropractic Manipulation

Once the participants were selected, they were treated according to the Activator Methods Chiropractic Technique (AMCT) protocol<sup>22</sup> for the presence of joint restrictions.

**Interventions.** Subjects of both groups received a standard AMCT evaluation, and subsequently, only the treatment groups received the usual treatment ranging from thoracic 12 to lumbar 5. The side on which the chiropractic manipulation was aimed was considered the PD side (PD for our recordings, whereas the opposite side was identified as the NPD side). The subjects in the treatment group received a single thrust from the instrument on the different sites that needed to be manipulated based upon the protocol findings during each visit, and they received no other treatment. The manually assisted mechanical force was produced using an Activator Instrument IV at the indicated level 4 for the lumbar manipulation. The treating doctor of chiropractic (DC) held an advanced proficiency rating in AMCT.<sup>23</sup> The treatment protocol followed the AMCT protocol for clinical application of the instrument.<sup>22</sup> The instrument was loaded to engage the stylus, producing minimal tissue pull, and the handle was pressed to release the hammer and produce the chiropractic manipulation. The treatment group received 9 chiropractic spinal manipulation treatments over 2 weeks.

Asymptomatic subjects in the nontreatment group received the same evaluation but did not receive any type of treatment. They were evaluated, and the side that the protocol indicated might be treated was noted. The side that might be treated was considered the PD side for our recordings, whereas the contralateral side was considered as the NPD side. We chose to include a nontreatment group in this study to isolate the effect of the treatment.

### Outcome Measures

**Oswestry Disability Index.** The modified Oswestry disability index was used to evaluate lower back functional disability.<sup>10,11</sup> It is composed of 10 self-rated items on an A to F scale that evaluate the capacity of an individual to function during daily activities. The value of A = 0, and each subsequent letter has an ascending numerical value, B = 1 to F = 5. The maximum total score for all 10 items is 50. The total for all the answers is tabulated and multiplied by 2 to give a percentage of dysfunction due to lumbar pain. Those administering the Oswestry tests were blinded to the group assignment.

**Paraspinal Cutaneous Temperature.** The thermal scan was calibrated according to the calibration report—for the thermoglide/Tytron C-4000 [42150] provided by the distributor (Myovision system; Precision Biometrics, Inc, San Carlos, CA). The thermal scan was performed as follows:

The participant had been lying prone on a chiropractic table for 8 minutes. The starting point is S-2, and it has been

identified with a grease marker pencil. The instrument is positioned at that specific starting point and then rolled up the spine to cover the entire spine from sacrum-2 to the atlas.

The data were recorded directly into the computer software and exported afterward for analysis. The absolute PCT (in degree Celsius) for each paraspinal area of each segment was determined for every patient. The attending DC competent in the use of this technology did all the prerecording and postrecordings for both groups. The attending DC was not blinded to the grouping but was blinded to the results of the recording until the data were all recorded and analyzed.

### Experimental Procedures

When the participants arrived for the recording session, they completed the Oswestry disability index. Then they were asked to dress with a cotton gown that had an open slit in the back while wearing their underclothing. They then proceeded to lie prone on a chiropractic table. The treatment group was evaluated for the presence of pain, and the side of pain was noted. The nontreatment group was evaluated as well. The side of past complaint was recorded as the side of pain to establish a reference for further comparison. The participants remained in a prone position for 8 minutes, and then the PCT evaluation was performed. At the end of the recording, the participants were thanked and dismissed.

### Statistical Analysis

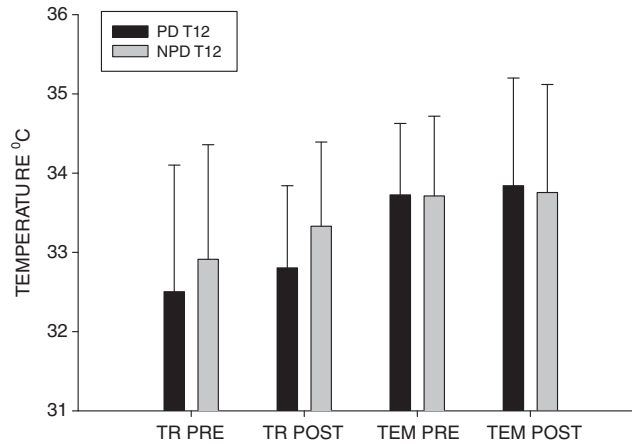
Descriptive statistics (mean  $\pm$  SD unless stated otherwise) were computed for all variables for both groups. Groups were compared based on the difference in the PCT from the level of t-12 to L-5 and its resulting effect size. We also compared the changes in the Oswestry index and measured the effect size of the treatment. Statistical analysis was performed using SPSS for Windows v15 (SPSS, Inc, Chicago, IL). The level of statistical significance was set at .05.

## RESULTS

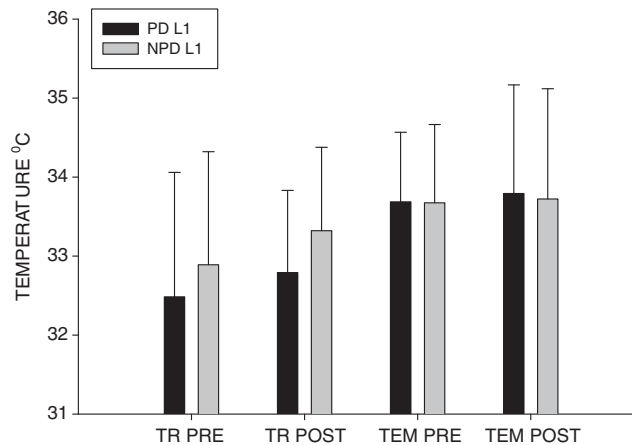
There were no significant differences ( $P > .05$ ) for the anthropometric characteristics of the subjects between both groups (Table 1). For the nontreatment group, a total of 10 participants were recruited, 4 females and 6 males. For the treatment group, a total of 11 participants were recruited, 4 females and 7 males.

### Oswestry Index

The overall Oswestry disability index average score evaluation for the nontreatment group was 10.2%  $\pm$  10.6% (Fig 1). For the treatment group, the overall average of the pretreatment Oswestry disability index score was 29.8%  $\pm$  11.8%, and the posttreatment was 14.20%  $\pm$  11.5% (Fig 1). The resulting Cohen's effect size of the spinal manipulation is 0.58. Cohen<sup>20,21</sup> gives the following guidelines: small effect size,  $r = 0.1$  to 0.23; medium,  $r = 0.24$  to 0.36; large,



**Fig 1.** Pretemperature and posttemperature of the treatment and opposite of the treatment side recording for both groups (TR, treatment; TEM, nontreatment group) at the level of T-12.



**Fig 2.** Pretemperature and posttemperature of the treatment and opposite of the treatment side recording for both groups (TR, treatment; TEM, nontreatment group) at the level of L-1.

$r = 0.37$  or larger. The Oswestry disability index was significantly greater ( $P = .0008$ ) for the treatment group when compared with the nontreatment group (95% confidence interval, 9.31-29.89).

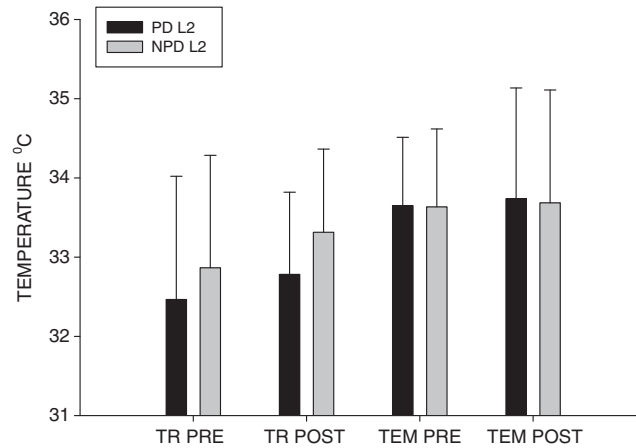
### Paraspinal Cutaneous Temperature

Paraspinal cutaneous temperature differences between both groups are illustrated in Figures 1 to 6, for each respective segment. As indicated, preintervention PCT of the pain free group is warmer; it varies from  $33.55^{\circ}\text{C} \pm 0.84^{\circ}\text{C}$  to  $33.72^{\circ}\text{C} \pm 0.90^{\circ}\text{C}$  on the PD side, and it varies from  $33.54^{\circ}\text{C} \pm 1.00^{\circ}\text{C}$  to  $33.71^{\circ}\text{C} \pm 1.01^{\circ}\text{C}$ . The treatment group preintervention PCT varies from  $32.42^{\circ}\text{C} \pm 1.48^{\circ}\text{C}$  to  $32.50^{\circ}\text{C} \pm 1.60^{\circ}\text{C}$  on the PD side, and it varies from  $32.80^{\circ}\text{C} \pm 1.40^{\circ}\text{C}$  to  $32.91^{\circ}\text{C} \pm 1.45^{\circ}\text{C}$ . Comparing the levels associated to low back pain, from levels from D-12 to L-5,<sup>24,25</sup> we observe that the nontreatment group premeasurement and postmeasurement

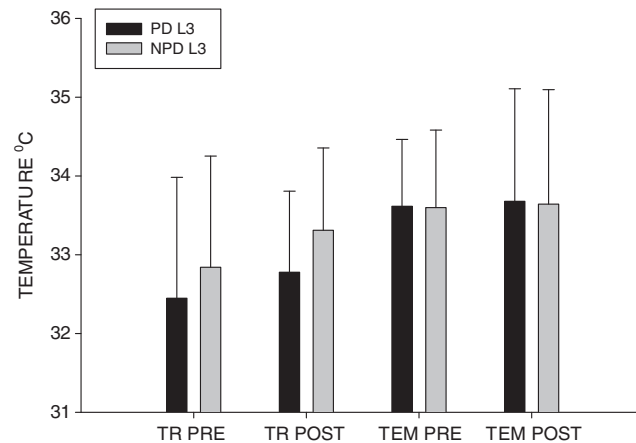
PCT differential varies from  $-0.01^{\circ}\text{C}$  to  $-0.05^{\circ}\text{C}$  on the NPD side and  $-0.01^{\circ}\text{C}$  to  $-0.12^{\circ}\text{C}$  on the PD side, whereas the treatment group premeasurement and postmeasurement PCT differential varies from  $-0.42^{\circ}\text{C}$  to  $-0.51^{\circ}\text{C}$  on the NPD side and  $-0.30^{\circ}\text{C}$  to  $-0.35^{\circ}\text{C}$  on the PD side. The minus sign indicates that the postintervention measurements of the PCT are warmer for each level concerned.

### DISCUSSION

The difference measured with the Oswestry questionnaire indicates that the treatment group showed a higher level of disability than the pain-free group. This significant difference ( $P = .0008$ ) found between the 2 groups allowed us to consider the groups different with respect to their low back pain condition. The data reveal that after the treatment period, the treatment group nears the Oswestry index values of the nontreatment group.



**Fig 3.** Pretemperature and posttemperature of the treatment and opposite of the treatment side recording for both groups (TR, treatment; TEM, nontreatment group) at the level of L-2.



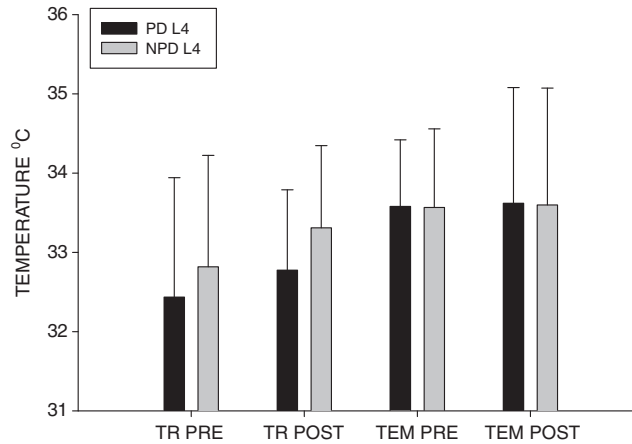
**Fig 4.** Pretemperature and posttemperature of the treatment and opposite of the treatment side recording for both groups (TR, treatment; TEM, nontreatment group) at the level of L-3.

The initial PCT measurement for the treatment group revealed that the treatment side (PD side) is colder than the nontreatment side (NPD side). We expected that the probable underlying inflammation of the injured lumbar area would present a warmer PCT on the side of pain or PD. This is also strikingly different from the concept of the inflamed area referred to in chiropractic.<sup>26</sup> In contrast, however, the overall PCT of the treatment group was cooler than the nontreatment group. Physiologically, we expected the contrary. The inflamed area of the treatment was expected to be warmer than the same area from the no pain group. This observation was in striking contrast to what was expected. However, Uematsu et al,<sup>17</sup> in his thermography studies, mentioned that the leg afflicted with sciatica was colder than the opposite leg, by 1.55°C ( $P < .001$ ).

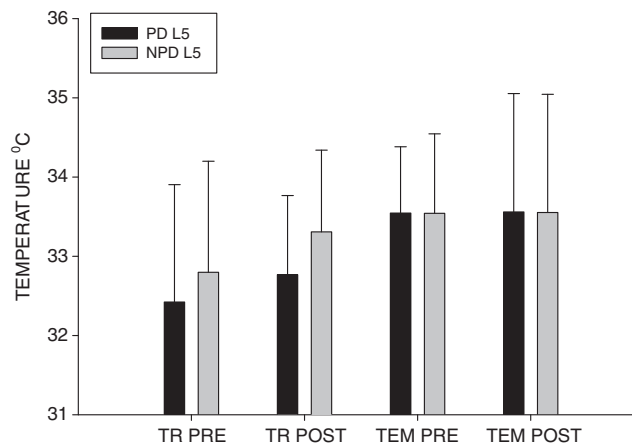
It should be noted that the muscle mass provides 80% of the PCT.<sup>27</sup> Thus, as low back pain limits the local muscular activity, could it then affect the PCT, which is represented by a colder PCT in the treatment group? According to

Manini and Clark,<sup>28</sup> hypoxia induces dramatic changes in muscle metabolism that can directly affect force production. Hypoxia is a potential source for reactive oxygen species (ROS) produced by tumor necrosis factor  $\alpha$ .<sup>29</sup> Tumor necrosis factor  $\alpha$  is a major mediator of inflammation,<sup>29</sup> and it was shown to normalize in patients receiving chiropractic care.<sup>30</sup> It is proposed that this is one of the mechanisms involved in the warming of the PCT in patients with chronic low back pain.

It was reported<sup>13</sup> that, in pain-free subjects in the prone position, the SD was between 1.05°C and 1.10°C for prone subjects and it varied between 0.99°C and 1.02°C for standing subjects. From 1 study,<sup>7</sup> the SD of the healthy participants was 0.80°C. In another study,<sup>9</sup> the SD of participants with acute low back pain was 0.79°C. The average PCT of participants in the acute low back pain study<sup>9</sup> was 33.31°C  $\pm$  0.79°C, and the average PCT of participants in the pain-free study<sup>9</sup> was 33.54°C  $\pm$  0.80°C, a differential of 0.23°C.



**Fig 5.** Pretemperature and posttemperature of the treatment and opposite of the treatment side recording for both groups (TR, treatment; TEM, nontreatment group) at the level of L-4.



**Fig 6.** Pretemperature and posttemperature of the treatment and opposite of the treatment side recording for both groups (TR, treatment; TEM, nontreatment group) at the level of L-5.

This differential is not within the 1 SD proposed by Uematsu et al.<sup>17</sup> In the present study, the difference from side to side in both our group barely exceeds the 1 SD. The differential between the pain-free group and the low back pain group varies, for the low back from D-12 to L-5, from 0.84°C to 1.05°C. This is the limit that we are setting at the moment because we have no comparative normative database. As Uematsu et al<sup>31</sup> proposed, these values can be used as a standard in assessment of sympathetic nerve function, and the degree of asymmetry is a quantifiable indicator of dysfunction. Then Uematsu et al<sup>31</sup> also proposed “with use of the data, an abnormal thermal asymmetry can be defined, based on a statistical criterion, from the normal differential of temperature for a specific body area, rather than by using a single unit value (1°C) for all comparisons. Because the vasomotor responses may vary depending on underlying conditions, the degree of thermal asymmetry may vary in different underlying pathophysiological conditions. Therefore, in certain clinical

cases, a differential of temperature value of less than 1°C may be significant.” There is possibly some future for this technology; we need to continue evaluating the other mechanisms involved as we mentioned one earlier.

We suggest that a PCT index (normal condition with pain free subject) should be created to investigate other mechanisms and the clinical application of this technology. Surely, more research is needed to better understand the relationship between inflammation and cutaneous temperature regulation. The conclusions of Uematsu et al<sup>31</sup> from his article where he suggests that it is important to obtain a normative data base support our view for the present thermography equipment as it is used for paraspinal thermal evaluation in chiropractic. He concluded “It is our belief that the differential temperatures we obtained for normal subjects may be used as a reference standard for comparison to differential temperatures obtained in most clinical examinations. Deviations from the normal values will allow suspicion of neurological pathology to be quantified

and therefore can improve assessment and lead to proper clinical management.”

### Limitations

This study has the following limitations. The cameras have limitations at 0.05°C. The cameras' physical limits are well within the SD measured. In this study, the participants PCT differential variation did not exceed at least 1 SD from the values a normal group to be of clinical value. Our group of participants was limited but did meet the statistical requirements; a larger group might provide a better representation. The nontreatment group participants were already participants who were aware of the methodology of treatment and had been under maintenance or support care, thus were not blinded.

### CONCLUSION

This study showed that the PCT readings for subjects with chronic low back pain were lower than the asymptomatic, nontreatment group. The PCT temperature of the treatment group increased after 9 treatments.

### FUNDING SOURCES AND POTENTIAL CONFLICTS OF INTEREST

Funding provided by the “Fondation de Recherche Chiropratique du Québec.” No conflicts of interest were reported for this study.

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