ORIGINAL RESEARCH

Mastoid Fossa Temperature Imbalances in the Presence of Interference Patterns: A Retrospective Analysis of 253 Cases

Myron D. Brown, B.S., D.C. [1] *& Arianna Coe, B.M., LMT* [2]

ABSTRACT

Objective: To determine how bilateral mastoid fossa asymmetry relates with other patterns of interference associated with vertebral subluxation analysis, employing state of the art thermography detection instrumentation.

Design: Bilateral thermographic mastoid fossa data for this study was compiled retrospectively by paraprofessionals from randomly selected "active patient files." A paraprofessional trained in paraspinal thermographic scanning randomly selected patient files making note of case numbers to preclude the possibility of duplication of patients. "Active patient files" are case records of patients receiving care on a scheduled basis in accordance with the established plan of care. The active patient files consisted of 552 case files. Mastoid fossa data were extracted from 139 randomly selected patient visits from among those wherein the doctor had identified the presence of patterns of interference and receiving atlas adjustments; and 114 randomly selected patient visits without patterns of interference.

Methods: On all prior visits the following four criteria were used to determine the presence of a pattern of interference: cervical paraspinal thermographic scan; mastoid fossa temperature differential; spinal balance (Thompson-Derifield) leg length and cervical syndrome leg length tests. The TyTron® scanner, model C-3000 was used to compile all paraspinal thermographic data. The data was randomly collected from a population of 552 active patient files. 139 patient visits were selected that displayed patterns of interference and received atlas adjustments; and 114 patient visits without patterns of interference.

Results: In the absence of patterns of interference a tendency toward bilateral mastoid fossa temperature symmetry (55.26% of cases) was observed. In the presence of patterns of interference there was less of a tendency for bilateral mastoid fossa Temperature symmetry (32.0% of cases). When asymmetry was found the average difference in fossa temperatures exceeded those observed using conventional tools. In patients displaying the presence of patterns of interference the fossa temperature tended to be cooler on the side of atlas vertebra laterality (SOL). It was also observed that the pre-adjustment balanced temperatures were fewer than the number of post-adjustment balanced temperatures.

Conclusions: The data suggests that there is a tendency toward bilateral mastoid fossa thermographic symmetry, especially in the absence of patterns of interference. However, bilateral symmetry is less likely in the presence of interference patterns. Additionally, the magnitude of the temperature differential was found to be greater than experienced with earlier instrumentation. It was also noted that in the presence of interference patterns associated with atlas listings the mastoid fossa tends to be more frequently cooler on the side of atlas laterality.

Key words: *Thermography, paraspinal, pattern of interference, mastoid fossa, Chirometer®, TyTron®, Neurocalometer®, Neurocalograph®, vertebral subluxation.*

Introduction

Practitioners of the healing arts have recognized thermographic aberrations associated with diverse maladies and disease states since ancient times. Paraspinal thermographic data has also long been recognized by chiropractors as a determinant associated with vertebral subluxation. Core temperature in humans is maintained within a very narrow range and the skin is very actively involved in thermal adaptation to maintain a constant core temperature.

1. Private Practice – Rock Hill, SC
2. Private Practice -

Observations of bilateral paraspinal thermographic imbalances and the eventual ability to objectively record thermographic data led to the recognition of patterns which tend to be unique to a particular individual. Furthermore, researchers have observed that the thermographic patterns appear to coincide with the presence of other signs of vertebral subluxation. It is theorized that these static thermographic patterns appear when reduced adaptive function abates the usually constant variations of skin temperature, interpreted as being indicative of the body's striving to maintain a relatively constant core temperature. Thus the presence of static patterns is presumed to be pathognomonic of an interruption to the adaptive process.

It is presumed that patterns, a demonstrable thermographic aberration, reveal a person's diminished capacity to adapt to his/her constantly changing internal and external environment, which can account for and link thermal patterns to vertebral subluxation. Since the brain and nerve system control and coordinate adaptation, a failure to properly adapt may be related to nerve system insult as produced by vertebral subluxation. In addition to paraspinal thermography (full spine or sectional scans) to detect patterns of interference, bilateral mastoid fossa temperature measurements have been used to identify thermographic asymmetry as well as thermographic patterns. Enhanced stability and reproducibility provided in recent years by advanced instrumentation has revealed that the actual bilateral temperature differentials of the mastoid fossae may be considerably greater than earlier data suggested. This study seeks to explore the impact of these greater differentials and identify their relationship to vertebral subluxation analysis. It is hoped that this information can shed light on the role of mastoid fossa measurements in vertebral subluxation analysis.

Background Discussion

Contemporary medical thermography tends to assume that symmetry is the normal state and focuses on thermal asymmetry to evidence the abnormal as noted by Hart & Owens, "*Temperature asymmetry has been observed in patients with a variety of health conditions… "*[1] A broadly accepted assumption in related literature is that thermographic symmetry is desirable while asymmetry is not. This assumption has been given what amounts to an *a priori* status and seems to be based upon its tendency to be absent in certain pathological circumstances. However, the assumption begins to appear arbitrary when considered in view of the fact that it fails to take into account or even include substantial samplings of the broader populations (persons without apparent deviations from "normal" – the asymptomatic population). In chiropractic thermography was similarly rooted, however as the chiropractic objective evolved to include this broader population, paraspinal thermography gained clinical application there as well. The importance of this distinction is that the purpose became more clearly focused on the relationship of thermographic findings to the vertebral subluxation, rather than just a sign of pain or sickness. Culturally, however, research is most often designed to engage the former samplings. This study was designed with this concern in mind. Some have sought to tie thermographic observations with health through health perception surveys and built interesting correlations.[2] Yet the practical application of this body of knowledge in vertebral subluxation analysis remains to be demonstrated.

Early chiropractors sought thermal asymmetries by gliding the back of the clinician's hand over the patient's spine. The assumption was that asymmetry identifies the location of vertebral subluxations. This is described in 1938 by the historian, A.August Dye,

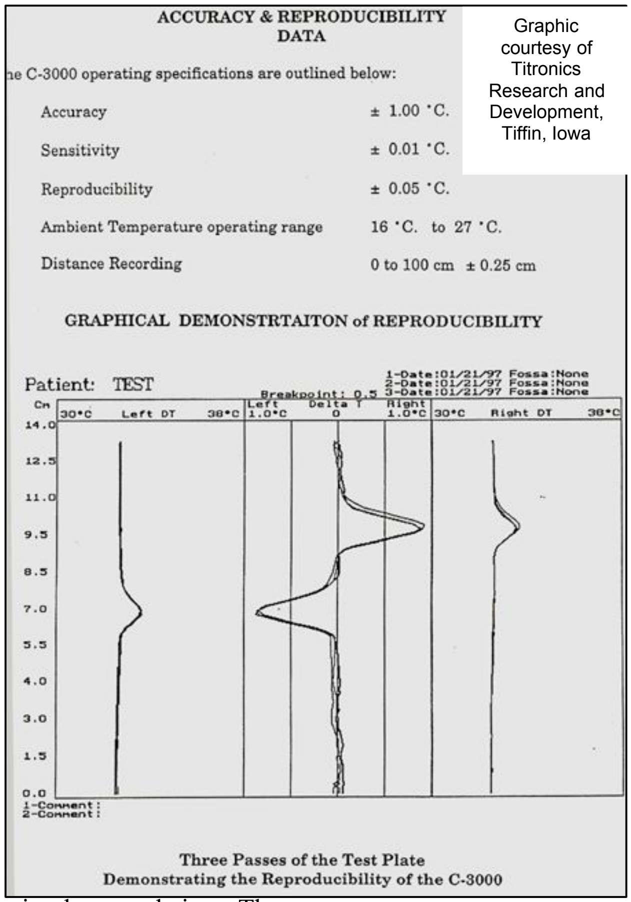
"*… places along the spinal column with an easily perceptible difference or increase in temperature on comparison with contiguous areas. Those places are called "hot boxes", usually determined not by digital palpation but by the application of the back of the fingers to the patient's back, along and over the spine. The presence of a "hot box" in conjunction with definite nerve tracing was and is yet accepted as a definite confirmation of a subluxation…*"[3]

This process was the origin of the "break theory" referenced later in this discussion. The Neurocalometer® (NCM), invented by Dossa Evins in 1923, was unveiled by B.J. Palmer in 1924 to add objectivity in measuring thermal asymmetry. Employing a series of thermocouples linked to a galvanometer, the NCM could reproducibly identify bilateral heat imbalances when glided along the skin of a patient's spine. An interesting development took place in 1936 when a B.J. Palmer Chiropractic Research Clinic engineer, Otto Schiernbeck, combined the NCM with a paper chart-recording device.[4] The instrument thereby devised was called the Neurocalograph® (NCGH). The NCGH represented a great leap in objectively recording and reproducing paraspinal heat variation data. The previously awkward and subjective hand recording representations of galvanometer needle swings did not reveal certain further observations, which would only become apparent with the advent of chart recorders to graph the data.

Bilateral observations made using the NCGH gave birth to the "pattern" approach (Fig. 1-2). Investigators began to notice uniquely individual designs in the bilateral paraspinal heat variations that seemed to be identifiable as a patient's own distinctive, "pattern." These thermal imbalances seem to show up consistently at the same vertebral levels and persistently do so in the same direction (i.e. a warm or cool spot on the skin on one side of the spine that appears on the same side and at the same level each time the data is taken, is considered an element in a patient's pattern). The pattern concept represented a paradigm shift for these early researchers as described in Palmer's 1961 text, *"… each case has a certain heat line graph pattern which is characteristic to that particular case… Patterns are 'finger prints'.*"[5] In the new paradigm the existence of a pattern was associated with the *presence* (but no longer the location) of vertebral subluxation. This contrasted with the break theory, which preceded it. Breaks (sharp horizontal paraspinal thermographic disparities) had previously been thought to identify the *location* of vertebral subluxations. The reliability of the presence of patterns seemed to correlate well with the presence of vertebral subluxation while the correlation between the level of a subluxation and breaks was becoming blasé in the view of these researchers and clinicians.

Correlative neurocalograph studies revealed that persistent breaks would tend to clear up after correction of subluxations at locations distant to the actual breaks. In view of this information, thermal findings became less applicable to the *location* of vertebral subluxations and gave way to the use of patterns to evidence the *presence* rather than the exact location of a vertebral subluxation. Nevertheless, and perhaps due to its simplicity, the "break concept" continues to be used as a tool in some proprietary technique systems. The thermographic data utilized in this study was employed to identify patterns as an indicator of vertebral subluxation as noted in a contemporary technique textbook compiled by the faculty for use in the curriculum of a chiropractic college:

"*Observations of patterns in patients with vertebral subluxation and the absence of identified patterns after correction have demonstrated the value of the pattern concept...the presence of interference patterns suggest that the patient is not adapting successfully and this conclusion may be closely related to the presence of vertebral subluxation.*"[6]



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The Mastoid Fossa

B.J. Palmer introduced another thermographic device in 1953, the Chirometer®.[7] This single-probe thermocouple instrument was designed to measure the actual skin temperature in each mastoid fossa. Differences between the actual temperature of the right and left fossae were observed and recorded in the patient record. The mastoid fossa provides a generally reproducible point for thermal measurement due to its ease of accessibility and the fact that it rarely has any skin irregularities, pimples, or hair. The Chirometer was studied correlatively in use with the other pattern analysis instruments in the B.J. Palmer Chiropractic Clinic (also known as, *The Research Clinic*) and the Clearview Sanitarium (both facilities were in Davenport, Iowa) for a period of months prior to its endorsement as an advancement to provide, *"additional information to solve borderline cases"*.[8] While it later was found to be applicable to the "pattern concept," the early Chirometer premise also involved an element of the "break concept." It was theorized that the proximity of the fossae to the neural canal and the first set of cervical nerve roots would result in bilateral thermal asymmetry in the fossae when upper cervical nerve tissue insult caused excess heat to be generated locally. An expectation of bilateral symmetry in fossa temperature as the norm was the original basis for taking Chirometer measurements. Early clinical observations suggested a relationship between the side of atlas vertebra laterality (when subluxated) and cooler fossa temperature. Chirometer variations in the fossae temperatures tended to be less than 1.0 degree. In fact the Chirometer manual suggested that a difference of 0.5 degree should be considered an indicator of nerve intereference.[9]

The technology for taking mastoid fossa thermal data advanced with the introduction of the TyTron® scanner, a dual probe digital infrared scanner. With computer display and storage capability, it combined the functions of several earlier paraspinal thermographic instruments including the thermocouple based Neurocalometer® (NCM), Neurocalograph® (NCGH), Dermathermograph® (DTG), Synchro-Therme®, Tempometer®, Chirometer® and a later model of the Chirometer®, called the ChiroTherm®. Engineered with a collimating thermal mass and focusing lens to provide stability and reproducibility, the TyTron® is accurate to within 1.0 degree centigrade and sensitive to within .01 degrees centigrade (see adjacent specifications chart). The first prototype and subsequent production models of the TyTron® scanner were investigated and placed into use by the author in West Liberty, Iowa. More than ten years of clinical experience with it and subsequent models demonstrated that patterns of interference could be identified consistently.

Method

The TyTron® scanner model C-3000 was used to determine all paraspinal thermographic data in this study. Identity blinded patient records at the West Liberty Chiropractic Center, West Liberty, Iowa were reviewed as the data source. Bilateral thermographic mastoid fossa data for this study was compiled retrospectively by a paraprofessional from randomly selected 'active patient files'. A paraprofessional trained in paraspinal thermographic scanning collected data, which was randomly selected from files making note of case numbers to preclude the possibility of patient duplication. 'Active patient files' were case records of patients receiving care on a scheduled basis in accordance with the established plan of care. The active patient files consisted of 552 case files. The active patient files represented a broad sampling of a family oriented practice. Therefore people of various ages, from infancy to elderly, including patients both with and without reported symptomatic conditions were included. Mastoid fossa data were recorded on 139 randomly selected patient visits wherein the doctor had identified the presence of patterns of interference and 114 randomly selected patient visits without patterns of interference.

In all cases clinical decision making was the responsibility of the chiropractor who relied upon a preponderance of consistent and persistent data coalesced to determine the presence of a pattern of interference. Patterns of interference were sought to identify the presence of vertebral subluxation; with thermographic patterns serving as the principal indicator since the reliability of thermographic patterns in spinal analysis has been established:

"*As an analytical tool paraspinal thermographic patterns have become one of the strongest elements in the process of spinal analysis that when using sound protocols are objective, reproducible and rate high in inter and intra examiner reliability.*"[10]

When a determination was positive for the presence of pattern of interference it was indicated in the active patient file. On all visits from which the study populations were selected, the following four criteria were used primarily to determine the presence of a pattern of interference: cervical paraspinal thermographic scan; mastoid fossa temperature differential; spinal balance (Thompson-Derifield) leg length tests; and cervical syndrome leg length tests. Daily visits were recorded in patient records follows:

a. 'Cervical syndrome' was recorded as positive when the spinal balance test revealed a leg length deficiency that balanced when the head was rotated to one side.
b. The cervical paraspinal thermographic 'scans' were recorded as *pattern* or not based on visual and/or computer-aided interpretation.
c. Paper clinical records of mastoid fossa data and all other clinical records were kept along with electronic records. Findings with differences less than .25 degree centigrade to be recorded as 'balanced'.

Secondarily, the following clinical observations were documented in the patient record to aid clinical decision making and to supplement the data relating to the presence of a patterns of interference: range of motion; muscle testing to confirm established listings; and vertebral challenge to confirm established listings. However, none of the secondary findings were drawn upon in tabulating the data for this study.

Thermographic Protocol

Long established chiropractic instrumentation protocols were originally developed in the *Research Clinic* by B.J. Palmer and staff to enhance the reliability and reproducibility of data taking with thermocouple based instruments. In order to remove variables that may have impacted data gathering, subjects were scanned in grounded and shielded booths to eliminate the effects of static electricity, radio waves, earth's magnetic fields, ambient temperature shifts and other variants. Also controlled were patient posture and synchronization of recording equipment with speed of the instruments. Palmer stated that these constants were followed rigorously in establishing the protocol on 203,824 graphs.[11] Chiropractic clinicians seeking to identify thermographic patterns in patients typically followed those protocols or similar variations thereof. The methods used in this study have their basis in these established protocols.

Protocol side note:

With the use of infrared sensors it is commonly accepted that direct contact with the patient's skin is unnecessary and undesirable. This concern is based in thermodynamic attributes of direct contact. With direct contact more heat transference takes place than without contact. This, along with an apprehension about being able to measure the skin temperature adjacent to the upper cervical region, which is often covered by hair, gave rise to a concern about the established protocol, which involved contact. For these reasons a series of correlative experiments were performed during the final stages of development of the TyTron. The offices of Dr. E.L. Crowder in Davenport, Iowa were selected for that purpose. Dr. Crowder served as the Director of the *Research Clinic* prior to its closing (upon the death of B.J. Palmer). Dr. Crowder's practice served as a model for student interns and chiropractors for more than 50 years and the protocols of the Research Clinic were scrupulously adhered to in his private practice.

To assess whether direct contact would require a protocol change, scans were taken using normal protocol with NCGH, constant posture chair, Tempometer (synchronized speed regulating device) and Chirometer. These were compared to scans taken on the same patients with the same protocols using the TyTron prototype. Scans held side by side were found to be essentially identical and they were found to be consistently reproducible when following the established protocol using direct contact. When the first TyTron C-3000 production models were produced they were placed in use in both Dr. Crowder's Davenport, Iowa office and the author's West Liberty, Iowa office. Over a period of several years both practitioners continued to report apposite results using the established, *direct contact* protocol. In view of the consistent outcomes it was reasoned that the most reliable findings could be obtained with the established protocols. This is because non-contact scanning gave rise to an even greater concern, incomplete data gathering and inconsistent scan lengths. This has been evidenced in a college clinic setting where TyTron scans have routinely been taken with a non-contact method by senior student interns and licensed faculty clinicians. The author reviewed numerous files compiled there and found that inconsistent scan lengths are the norm, not the exception. This outcome is not necessarily inevitable, but it is common as was noted by Hart, *"…Ideally, a thermal scan stops at exactly the same point for every scan; however, in actuality this does not happen due to examiner variations when attempting to stop at a given point on the spine for the purpose of comparing successive scans."*[12] With the TyTron instrument the stopping point is a crucial point of reference used by the software. A protocol that invites inconsistent scan lengths is unacceptable because identifying patterns of interference and reproducing scans depends upon a consistent stopping point. On many occasions the author observed that interns operating the instrumentation stopped their scans at various places in the mid-cervical spine (errors exceeding as many as 3 vertebral segments). This problem is minimized with direct contact, which assures a reproducible stopping point at the occipital shelf. With contact in the upper cervical region of the glide the clinician is able to include the entire cervical spine with reproducible scan lengths. These advantages were deemed to heavily outweigh the unrealized concern about error from heat transference. (*end side note*)

Thermographic protocols call for elimination of external stressors before taking scans. These include a wide variety of factors like thermal acclimation of the subject, time of day, and a consideration of substances taken internally that are known to have an impact on thermographic data. Hence the clinician must consider the unique circumstances of both the subject and the facility.

Specific characteristics of the protocol used in this study include:

- All thermographic data was obtained using the TyTron® C-3000
- Thermographic data was obtained on each visit prior to any handling or other clinical data taking.
- Thermographic data was obtained with the patient seated.
- TyTron® sound prompts were employed to signal start and stop of data taking for scans as well as fossa measurements.
- Right and left mastoid fossa temperatures were measured using brief light contact directly on the skin in the mastoid fossa holding the instrument at a slightly anterior-inferior angle to the fossa. *Important note: the Chirometer protocol called for pre-warming of the thermocouples prior to contacting in the fossa. This was done to minimize heat transference from the skin of the fossa itself. With infrared detectors, such as those used in the TyTron, pre-warming is not required or desirable; however, direct contact remains crucial for another reason. Although pre-warming is avoided, the direct contact with a consistent anterior inferior angle assures that the same small spot of skin in the mastoid fossa is measured each time. Owing to the geometry associated with focal spots as exists in the TyTron, small variations in the angle of the instrument will greatly change the area of focus resulting in the measurement of inconsistent points on the subject's skin. This effect is further magnified proportionally to the distance if the clinician fails to make a direct contact in the fossa.*
- Right fossa was measured first, followed immediately by the left, as regulated by the software.
- Pre-checks were taken after approximately 10 minutes of acclimation (clothed) subsequent to the patient's arrival. Infrequently the pre-rest time interval could extend to 20 minutes or more on particularly hot or cold days. Those patients were given an extra 10 minutes or more to adapt to the indoor temperature.
- Adjustments were followed by an interval of 15 to 20 minutes with the patient comfortably resting prior to post-checks. Rest booths featured dimmed lighting, soft music and either a recliner chair or cot. Blankets and pillows were within reach for comfort. The post-adjustment rest time is especially important to nullify the short term impact of handling the tissues when checking and performing adjustments.
- All data was stored in the electronic files and also charted on the patient's paper record. Mastoid fossa patterns become easier to spot when displayed progressively through numerous visits.

Results

A. Clear Check Data

- When a preponderance of pattern of interference criteria was absent these visits were deemed "clear checks" and no adjustments were given.
- There were 114 samples of data taken representing "clear check" visits (wherein no adjustments were given).
- On clear check samples (no of pattern of interference) 55.26 % had a mastoid fossa finding recorded as balanced.
- On clear check samples (no of pattern of interference) 22.80% had a mastoid fossa finding recorded as warm on the right.
- On clear check samples (no of pattern of interference) 21.93% had a mastoid fossa finding recorded as warm on the left.

B. Atlas Listing Data

Each of these subjects displayed a preponderance of pattern of interference criteria. On these visit dates an atlas vertebra subluxation listing was adjusted. Atlas adjustments were performed using a toggle-recoil adjustment on a Rock Side Posture table with drop headpiece. Both pre and post-thermographic findings were taken according to the above protocol.

- There were 139 random samples selected from visits when an atlas adjustment was required.
- In the presence of patterns of interference 32.37 % had a balanced mastoid fossa on pre-check. On post-check the number of balanced fossae

increased only slightly to 33.09 %. The balanced post-check percentage was 42.45% when including post-checks with minimal temperature shifts (less than 0.25°).

- 40.29% of post-check fossa temperatures demonstrated movement toward balanced; and 24.46% demonstrated movement away from balanced.
- 41.73% of post-check fossa temperatures moved higher on the side of adjustment contact; and 23.02% moved higher on the side opposite adjustment contact.
- On pre-test the mastoid fossa was cooler on the side of atlas laterality in 43.17 %; it was warm on the side of atlas laterality 24.46 %; and 32.37 % balanced. However, on post-adjustment tests this tended to even out with only 31.65% cooler on the side of atlas laterality; 35.25% warm on the side of laterality; and 33.09% balanced on post-check.

Discussion of Results

With the development of infrared detectors for mastoid fossa measurements, it became quickly apparent that greater bilateral differences existed than was observed with the use of thermocouple instruments. 6.14% of the "clear check" data demonstrated differences between 1.0 and 2.0 degrees, whereas Chirometer data rarely demonstrated temperature differences between the fossae exceeding 0.5 degree. This difference is even more remarkable when considering that the Chirometer measured temperature in degrees Fahrenheit, a much finer (smaller) scale than are the increments in centigrade degrees. It is suspected that the greater magnitude of differences with infrared detectors may be due to the following factors:

1. A quelling effect on sensitivity of the instrument produced by the intentional pre-warming of the thermocouples of the Chirometer.
2. Greater sensitivity (resolution) inherent in the TyTron instrument (.01 degree centigrade). Exact specifications for the Chirometer are unavailable; however, the Chirometer manual suggests that its resolution is reliable to within ½ degree Fahrenheit within its normal operating range, which is between 60° Fahrenheit to 140° Fahrenheit.[13] It is also interesting to note that some practitioners have reported difficulty interpreting the fossa data taken with the greater sensitivity of a TyTron. Reportedly it has been more challenging than it was to interpret results with the lower levels of sensitivity provided by Chirometer data. This experience has been one of the motivating factors precipitating this study.

In the absence of patterns of interference, 55.26% of mastoid fossae were recorded as balanced (see Fig. 3). This finding tends to support the original expectation for bilateral thermographic symmetry in normal patients. Only 15.79 % demonstrated more than 0.5 degree of bilateral temperature differential and 6.14% demonstrated a full degree or more of bilateral temperature differential. Thus, in the absence of patterns of interference it was found that there was a total of 21.93 % with considerable differential. In support of the expectation for bilateral thermal symmetry, one could expect near symmetry (difference of 0.5° C or less) approximately 78% of the time in the absence of patterns of interference.

In the presence of patterns of interference, 67.63 % of patients with patterns of interference revealed mastoid fossa thermographic imbalance (see Fig. 4). Of this group, 43.17 % had lower mastoid fossa temperature on the side of C-1 vertebra laterality, while 24.46% had higher mastoid fossa temperatures on the side of C-1 vertebra laterality. While this finding correlated with the observations associated with earlier "Chirometer" instrument findings the percentages of "cooler on the side of atlas laterality" are lower than what was expected. In the post check data this finding reversed with the "cooler on the side of atlas laterality" being the smallest sampling (see Fig. 5).

There was a modest increase from 32.37% to 33.09% balanced fossa temperatures in post-adjustment checks. It was observed however that most (69.23%) of the balanced pre-checks that had become slightly imbalanced upon post-check demonstrated an increased temperature on the side of adjustment contact. Those post-checks with minimal temperature shifts (less than .25°), *which began as balanced on pre-check* and moved slightly to imbalanced on post-check, when included in the "balanced" cohort brings the post-check percentage substantially higher to 42.45% (see Fig. 6). Also noted in post-check findings was a tendency for the fossa on the side of adjustment contact to be warmer (41.73%). In the absence of patterns of interference 22.80% of the temperature samples were higher in the right mastoid fossa and 21.93% were higher on the left.

Conclusions

These data appears to support the expectation for bilateral thermographic symmetry at the mastoid fossa when other interference patterns are absent. A tendency for mastoid fossa temperature to balance bilaterally on post-adjustment findings was noted. One of the least expected findings was the failure to find a higher percentage of balanced fossae post-adjustment. Also the expectation for a cooler mastoid fossa temperature on the side of atlas laterality was mildly supported. However, the percentages of all of these are lower than anticipated and further research is needed to determine whether these findings would hold true with larger samples of data and where protocol variations exist. Also noted in post-check findings was a tendency for the fossa on the side of adjustment contact to be warmer. This might be the result of handling of the warmer tissues and the impact of force from the adjustment locally. In that case, additional studies with increased rest time after the adjustment might diminish this finding.

A stronger inference could be drawn about the finding that demonstrated that bilateral symmetry is considerably less likely in the presence of interference patterns. This should be useful information for the clinician.

Overall, the magnitude of the actual temperature differential in the mastoid fossae was found to be greater than originally assumed based on experience with earlier instrumentation. This may be the reason for the smaller percentages of balanced findings than were observed with the earlier thermocouple devices.

It must be noted that all of the data in this study relied upon clinical conclusions drawn by a single chiropractor. While measures were taken to avoid subjectivity, the potential for error entering into clinical decision making cannot be totally discounted. In favor of this model however is the number of patient visits compiled and the fact that intra-examiner reliability when using consistent protocols speaks to some assurance of constancy. Nevertheless, subsequent studies are needed to provide more insight regarding the reliability of these findings.

One question to consider relates to the earlier discussion of anticipated symmetry i.e., can bilateral symmetry itself be considered an abnormal *pattern*? Based upon these data, people remaining clear of vertebral subluxation for prolonged periods of time might not show any bilateral mastoid fossa temperature differences. This, in and of itself, would contradict the expectation for rather constant fluctuations as the pattern concept suggests. The contemporary trend is to reject the earlier theory, which suggested that asymmetrical fossa temperatures resulted of inflammatory responses of the first pair cervical nerve roots in the presence of atlas subluxation. The argument against it suggests that autonomic and vascular impacts are more likely influences. A useful direction for further study would be to focus on the actual source of the temperature imbalances.

This study made no distinctions regarding the age of the subjects. Amongst clinicians using thermography, an anecdotal reference is commonly heard regarding the usefulness and perceived reliability of Chirometer findings to indicate the presence of vertebral subluxation in children. Another question for future study involves the use of fossa differential measurements on children. Whether the results found in this study would be proportionally the same in children; whether they would be similar with non-contact protocols (which were never used in this study); or the affect of differing facilities would all be useful next steps.

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Table 1
Correlation between balanced fossa temperature and pattern of interference (see Legend #1)

		Pattern of Interference (see Legend #3)
Balanced Fossa Reading (see Legend #2)	**Pearson Correlation**	.233
	Sig. (2-tailed)	.000
	N	253

Legend (ref Table 1)

1. Mastoid fossa temperatures were recorded on a randomly selected 114 participants that did not receive a chiropractic adjustment (determined to be "clear", or not in pattern) and combined with pre-adjustment mastoid fossa temperatures from another randomly selected 139 participants found to be in-pattern and in need of an atlas adjustment. Both populations were subdivided based on temperature differential between sides with a determination made for those in both populations that had balanced readings (see 2). See Fig. 3 and Fig. 4 for distributions of data for seed populations. The variables of "balanced reading" and "in-pattern" from this combined dataset were analyzed in IBM's PASW ver. 18 for significance and correlation. A weak correlation was found between balance and pattern of interference but the p-value was found to <.000, strongly suggesting they exhibit a statistical relationship (rejecting null hypothesis).
2. Numerical representation. "1" means patient record had a balanced reading and "2" means there was an imbalanced reading. Temperature readings were taken bilaterally with a "TyTron C-3000" (see Methods). Patients were found to be balanced if the temperature differential between right and left sides was than +/- .2 degrees.
3. Numerical representation (binary). First population was indicated with a "0" which meant no pattern of interference (n = 114) and second population was a "1" (n = 139) which indicated a pattern had been detected.

Table 2

Correlation matrix of fossa temperature subdivisions pre and post adjustment (see Legend #1)

		Pre Adjustment Fossa - High on side of laterality	Pre Adjustment Fossa - Low on side of laterality	Pre Adjustment Fossa - Balanced
Post Adjustment Fossa - Balanced	**Pearson Correlation**	**-.029**	**-.050**	**-.123**
	Sig. (2-tailed)	**.730**	**.558**	**.147**
	N	**139**	**139**	**139**
Post Adjustment Fossa – High on side of laterality	**Pearson Correlation**	**.073**	**.047**	**-.200**
	Sig. (2-tailed)	**.389**	**.582**	**.018**
	N	**139**	**139**	**139**
Post Adjustment Fossa - Low on side of laterality	**Pearson Correlation**	**-.096**	**-.087**	**.071**
	Sig. (2-tailed)	**.257**	**.306**	**.407**
	N	**139**	**139**	**139**

Legend (ref Table 2)

1. Mastoid fossa temperatures were recorded pre-adjustment and post-adjustment from a randomly selected 139 participants found to be in-pattern and in need of an atlas adjustment. Pre and post fossa measurements were subdivided into three groups. IBM's PASW ver. 18 was used to test significance and correlation (displayed in a matrix) between the pre and post states. The only state that stood out as having any statistical relevance was that of "Pre-adjustment Fossa – Balanced" and "Post Adjustment Fossa – High on side of laterality" with a p-value of <.02.

In figure #1 (below) is depicted an example of thermographic pattern. On this particular patient's visit (2/6/2008 green line) the scan parallels that individual's established pattern (12/5/2007 red line). Thermographic pattern is viewed in the delta temperature (center box as highlighted by the red and green arrows):

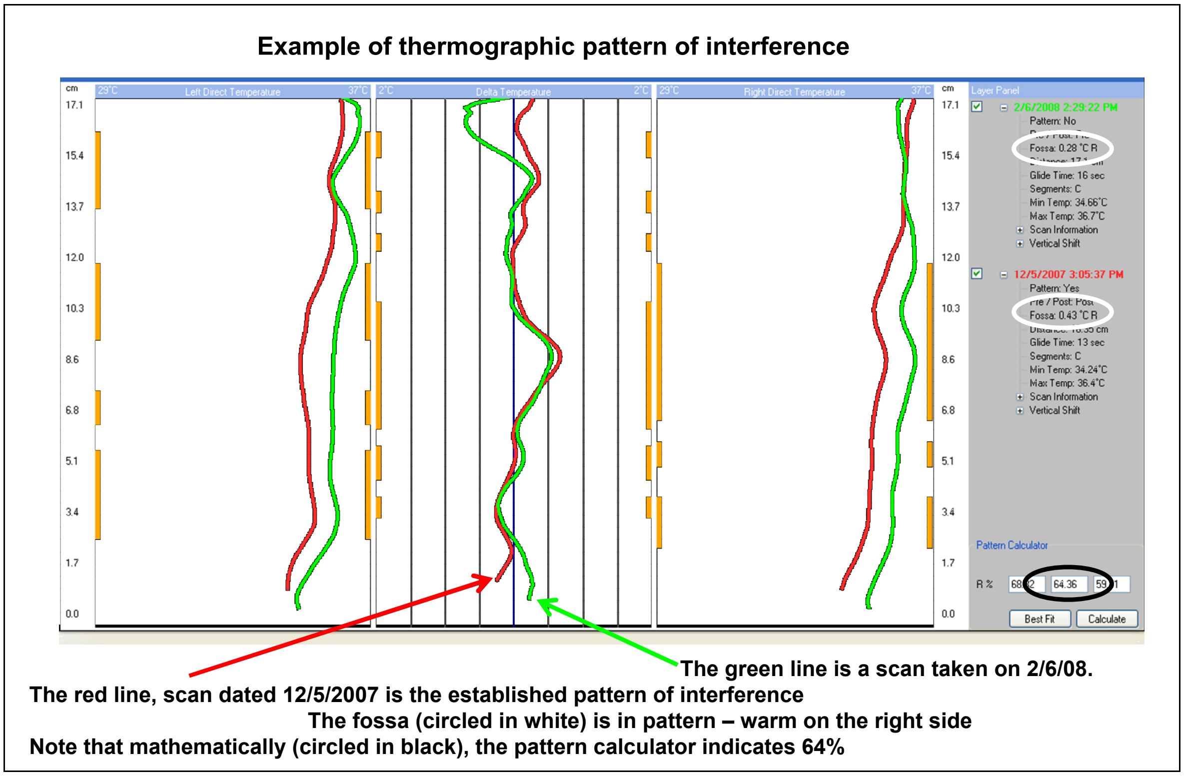

Figure # 1: TyTron (model C-5000) display of an actual patient file when patient is in pattern.

Below is an example of a visit when that patient's pattern is *not* present (same patient as Figure 1):

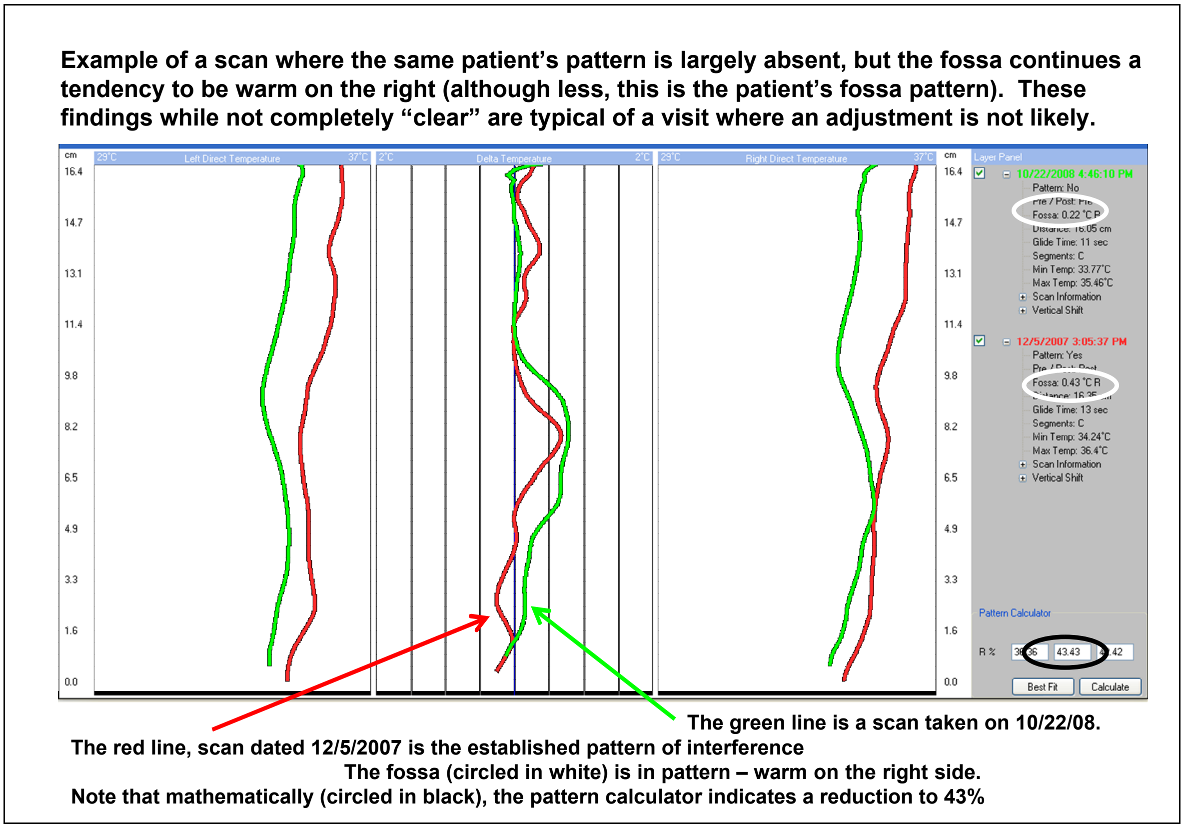

Figure #2: TyTron (model C-5000) display of another visit date from the same patient file.

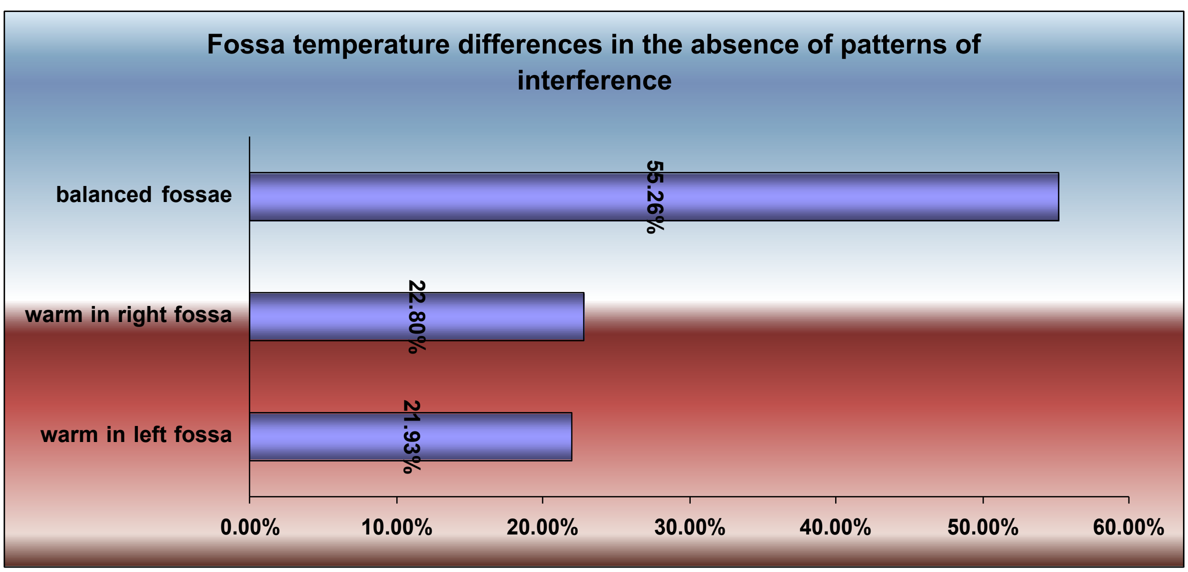

Figure 3: Graph demonstrates the tendency for balanced mastoid fossae in the absence of other patterns of interference. Warm in right fossa = right fossa temperature found to be higher than left fossa temperature. Warm in left fossa = left fossa temperature found to be higher than right fossa temperature.

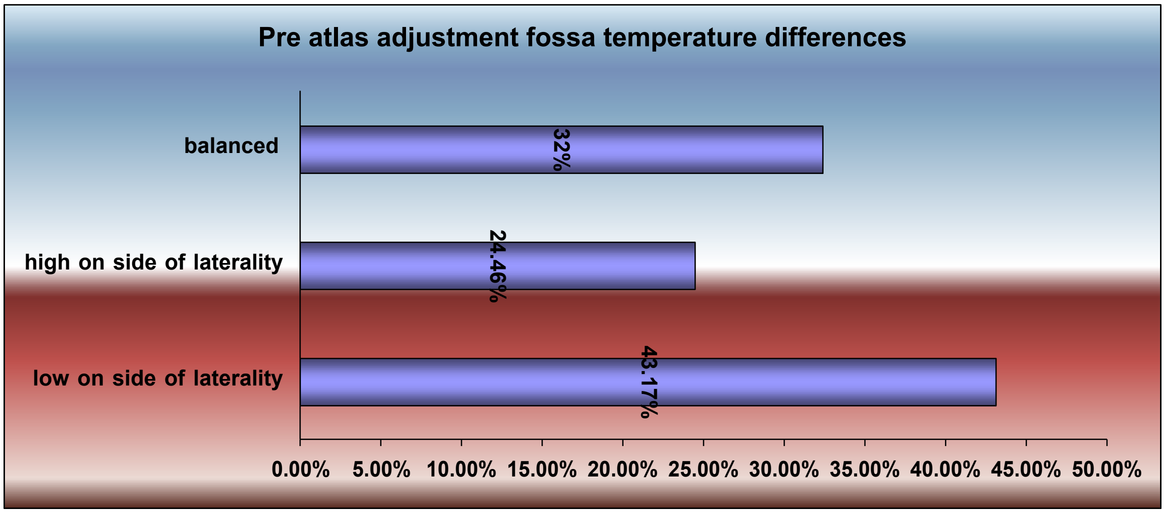

Figure 4: high on side of laterality = warmer on SOL; low on side of laterality = cooler on SOL.
In the presence of patterns of interference, more than 2/3 of subjects had imbalanced mastoid fossa temperatures.

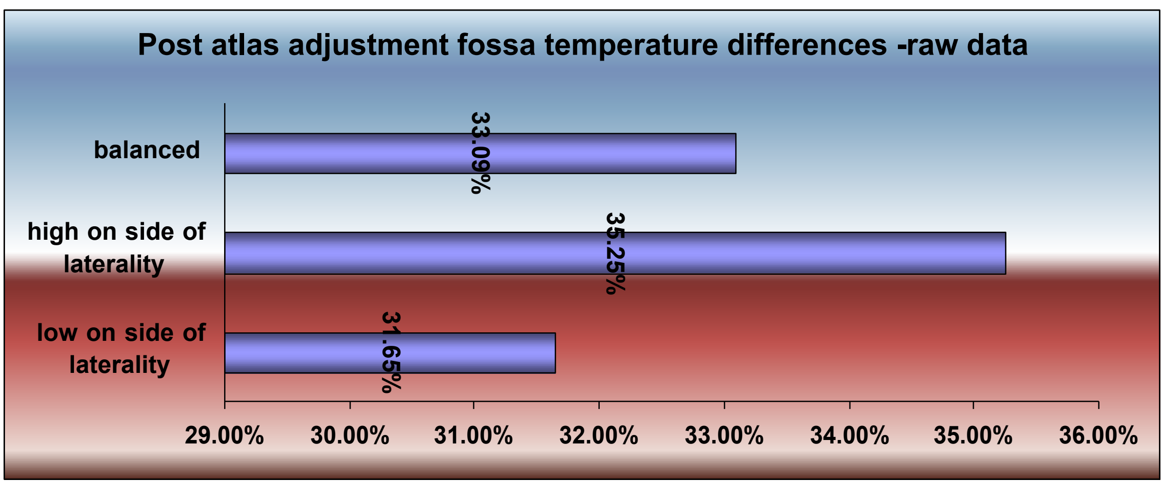

Figure 5: high on side of laterality = warmer on SOL; low on side of laterality = cooler on SOL. In the post adjustment group, "cooler on SOL" became the smallest sampling.

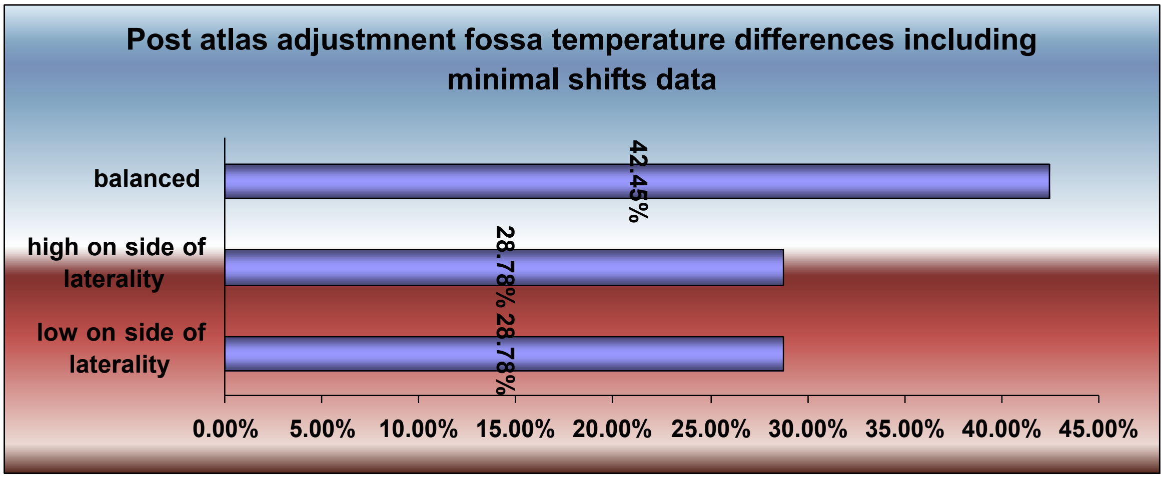

Figure 6: high on side of laterality = warmer on SOL; low on side of laterality = cooler on SOL. The balanced post-check percentage was 42.45% when including post-checks with minimal temperature shifts (less than 0.25°).