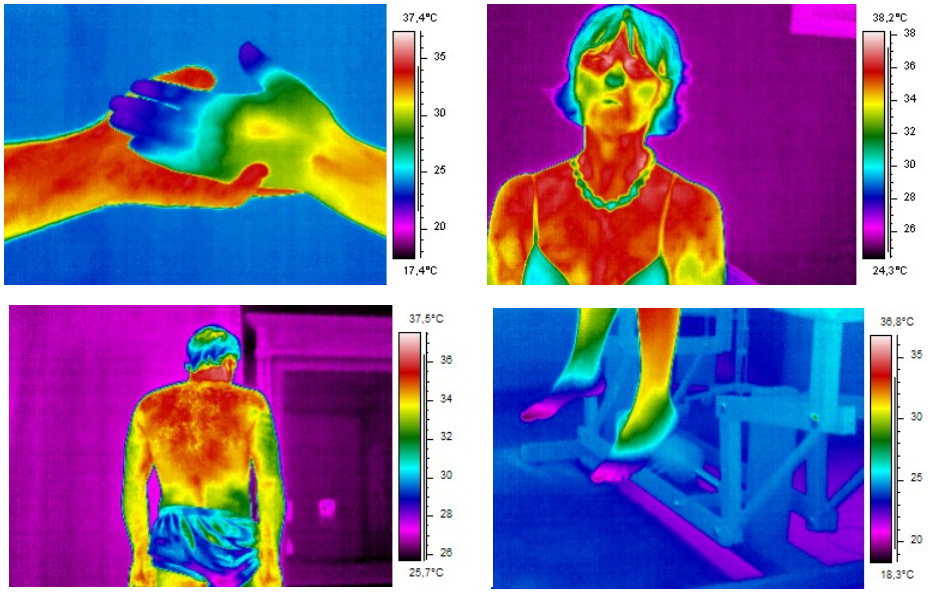
Impact of Osteopathic Treatment Shown by Radiometric Infrared Camera: Vascular and Thermal Modifications



“The rule of the artery is absolute…”

Andrew Taylor Still

Philippe Andreani
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« The rule of the artery is absolute, universal, and it must be unobstructed, or disease will result. »[1]

STILL, *Autobiography* 1908.

Context

What occurs during tissular dysfunction?

"The rule of the artery is absolute," wrote Andrew Taylor Still, and his words have continued to guide our study and practice of osteopathy. The artery carries blood from heart to tissue: it colours, nourishes and warms tissue, so the body emits heat. When there is tissular dysfunction, we may suppose that the change in the tension exerted on tissue will modify blood flow and provoke a change in temperature at a certain spot, which may or may not be adjacent to the lesion.

Objective:

Use modern scientific technology and equipment to assess, describe and quantify thermal variations on the body surface that are caused by tissular dysfunction. Measure the impact of a session of osteopathy on the distribution of cutaneous temperatures and demonstrate differences before and after treatment.

Method:

Infrared thermal imaging is based on an analysis of temperatures on the skin's surface; colours in the image reflect the physiology of the skin. We used a radiometric infrared camera at two physics laboratories in Paris and then in our offices, on 115 patients, during two 2-week periods in 2008, filming before, during and after osteopathic treatments according to a research protocol established with the help of two engineers specialised in thermography. The camera allowed us to visualise and record the thermal effects of different treatment actions, so that we were then able to analyse, verify and critically examine experiments. We chose to film as wide a range of patients as possible, from among those who came to the office for a consultation and agreed to participate in the experiment: men and women of various ages as well as adolescents, children and babies. Successive analyses of the digital data recorded helped us improve subsequent recordings, check a number of hypotheses and formulate others.

Results:

Changes in temperature before and after osteopathic treatment could be measured in °C; variations ranged from a few degrees (average of 2°C to 5°C) to much higher values (>10°C).

Conclusion:

Immediate, quantifiable thermal phenomena can be observed on the body surface after osteopathic treatment with the aid of infrared radiometry. We can put forward the notion that osteopathic manipulations have an immediate impact on the vascular compression of arteries and veins, which is linked to specific tissular dysfunctions. Biomechanical, muscular and articular quality is changed and improved. This thermal research demonstrates the compressive and inflammatory nature of some functional problems. Other experiments will be needed to confirm this initial research, develop new paths of investigation and offer solutions to a number of medical pathologies.

1 Andrew Taylor STILL, *Autobiography* ,Vannes: Sully, 1908.

"The rule of the artery is absolute" said the inventor of osteopathy more than a century ago, and his words have guided our study and practice of osteopathy ever since. Andrew Taylor Still must have put his finger on a concept vital to tissular equilibrium and homeostasis, as his ideas have nourished generations of practitioners before us and are still being used. But just what is this "absolute role" of the artery? What actually happens during a dysfunction that makes such a statement justified? The artery carries blood from the heart to our organs, intestines, muscles and all other body tissues, providing them with colour, nourishment and warmth, and allowing healthy bodies to move and function.

When blood is circulating properly through the vascular system, the skin has colour and is warm. When blood is not circulating as it should, we may suppose that the reverse is true: the vascular system is not operating properly; the skin has less colour and is not as warm. We may be tempted to make a connection with what happens in case of trauma or any other type of tissular dysfunction when kinetic energy—entirely external or introduced by an internal stressor encounters the body.

When patients complain of stiffness—what specialists call a "dysfunction of the micro-mobility of body tissues, causing functional problems that may interfere with health[1]"—they often add temperature-related details such as: "My neck hurts, I must have caught a chill", "It doesn't hurt as much when it's warm" or "It feels like my shoulder is on fire". There are many examples and everyone has felt it for himself at least once. Today science has at its disposal highly advanced technical resources to explore human health, and these technologies and equipment provide increasingly detailed and exact information. MRI, scans, angiographs, EEGs, etc. all unveil secrets hidden within the body itself and help us formulate new hypotheses on its physiology.

When the body emits heat, we call it thermal radiation. Emissivity is its efficiency in emitting this radiation in the infrared sector of the electromagnetic wave spectrum. This surface temperature can be recorded using a radiometric thermal camera. When a tissular dysfunction occurs, we may suppose that the change in pressure exercised on these tissues will modify the vascular system and its radiation, so there may be a change in temperature near—or at some distance from—the lesion. The osteopath perceives information; sometimes this perceived information points to zones not indicated by the patient. Yet what is perceived empirically can be measured and filmed using infrared radiometry, allowing the osteopath to visualise actions in progress and their effects and analyse them later.

Can analysis of the body's surface temperature—and changes in that temperature—be used to establish a diagnosis? Monitor the effects of a treatment? By analysing images recorded with an infrared thermography camera capable of digitising radiometric information, we have undertaken a study of the relationship between a specific treatment and the body's immediate thermal reaction.

Thermographic study performed in 2008/2009 with the agreement and cooperation of 115 patients.

METHODOLOGY

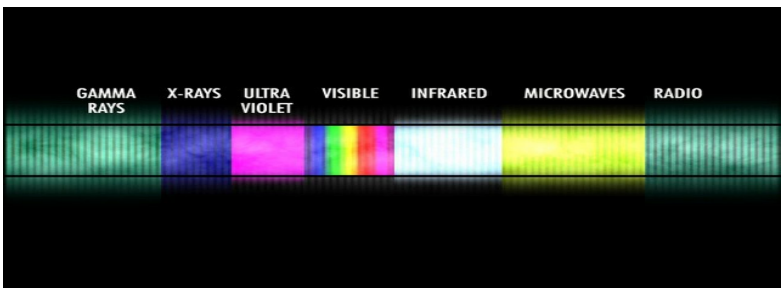
1 Equipment

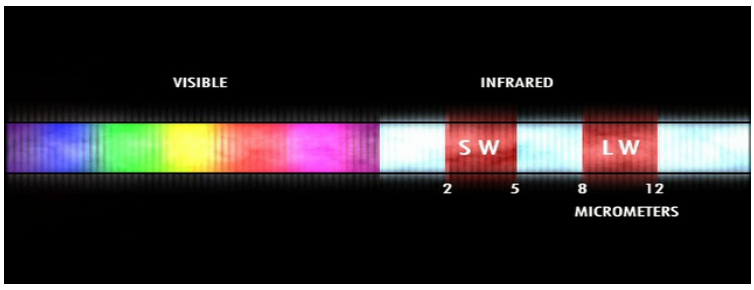
We used an A 320 Thermovision camera with Researcher™ software. The camera, made by Flir Systems, had a thermal resolution of 8/100 degree (0.08°Celcius), i.e., 80mK (milli-Kelvin) with non-cooled thermal detectors. We worked in close cooperation with thermography professionals.

2 Physics of infrared thermography

Infrared light covers part of the electromagnetic spectrum.

Our eyes are in fact captors designed to detect visible light. Other forms of light (or radiation) are invisible to the human eye, which is sensitive to only a small part of the electromagnetic spectrum.At one end of the spectrum is ultraviolet light which, like gamma rays and X-rays, are invisible to us. At the other end are infrared light, radio waves and microwaves, which are also invisible to our eyes. The main source of infrared radiation is heat or thermal radiation. All





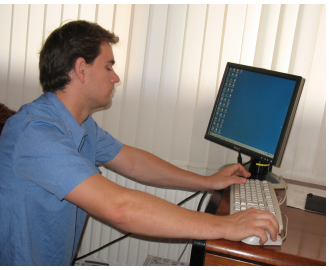
objects with a temperature above 'absolute zero' (-273.15°C), otherwise known as O° Kelvin, emit infrared radiation. Even objects we perceive as very cold, such as ice cubes, emit this radiation. Infrared radiation is part of our daily lives: we perceive it as heat from the sun, a fire or heating elements, for example.Although invisible to our eyes, infrared rays are detected by the nerves in our skin. Indeed, the skin has many captors that are sensitive to pressure, vibration, movement, pain and heat. Neurological and spinothalamic channels funnel information from thermo-receivers in our hand, for example, to identify hot and cold. The hotter the object, the greater the quantity of waves.

1 *Osteopathy using…,* Mérignac, French registry of osteopaths, p.2

What distinguishes all these waves is their length: infrared waves have a shorter wavelength than visible light. Max Plank's 1900 law of radiation means the hotter the object the more radiation and the shorter its wavelength. The normal internal temperature of the human body is 37°C. Maximum radiation is 9.3 micrometers. An IR camera is required to see it, and only the 8-12 micrometer waveband is of interest to us.

3 Radiometric infrared thermal cameras

The camera's lens focuses infrared energy from the patient's body on an IR (infrared) detector. This detector sends information to the electronic part of the sensor responsible for processing the infrared energy, converting it into an image that can be transmitted to the desktop computer via giga-ethernet cabling.IR thermography consists in changing an IR image into a radiometric image so that temperatures can be read remotely, directly, in real time, with no contact



and on moving bodies. To arrive at this result, the camera uses complex algorithms to produce thermogrammes.

These thermal images provide precise temperature measurements and can be used to detect the slightest differences in human body temperature. In addition, IR thermography as used in our osteopathy office was an entirely non-invasive method. The patient does not receive any radiation; it is the patient himself who emits heat. The entire system is controlled by computer; only the act of moving the camera towards the patient is done manually. The images recorded are converted into various formats (.jpg, .csv, .mat, .bmp, etc.). Data measurement, monitoring and analysis are made possible by the integration of ThermaCAM™ Researcher™ software protocols. Once installed under Windows, the software can be used to adjust the recording of images thanks to digital functions for reading temperatures such as: isotherm, measurement at a single point, profile of a line, histogram, image subtraction and selection, change of the thermal palette and digital zoom. Images are then stored in the computer's memory with Xnwiew programming software and saved on to disks and external hard drives.

4 Annecy infrared research protocol 2008/2009

1/ Sequences: radiometric images were stored over two study periods: 5-20 March 2008 (sequence 1) and 13-25 August 2008 (sequence 2). Total: 115 patients recorded in °C. Duration of a session with one patient: 45 minutes to 1 hour. Duration of the osteopathic treatment: 30 minutes average.
Place of study: Centre Médical et Paramédical, 24 rue Henry Bordeaux, 74000 Annecy/France

2 /Several actions were programmed:
2.A/ The study was carried out in such a way as to allow for subsequent analyses, verifications, critical examination, new hypotheses and new experiments. We filmed patients before, during and after treatment and commented aloud on actions and/or important perceptions, which were noted and later examined with older records. The films were then shown to patients and we recorded their answers and the dialogue, depending on whether it fit or did not fit with our former perceptions. Subsequent analysis of all our changes in perception and interpretation makes us more wary of our certitudes. Debriefing at the end of the day: analysis / criticism for the following day.

2.B/ Examination /filming of the site of pain described by the patient + filming of the stiff zone found by the osteopath. These two zones may be one and the same.

2.C/ diagnosis and treatment: film the therapist: his hands / at the beginning of the treatment and film the patient: standing / from the front / from behind + sitting + lying on back / stomach / before, during and after treatment

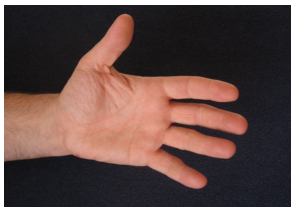
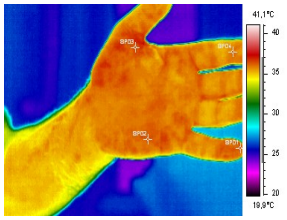
2.D/ pathologies targeted: we chose patients according to three types of references: 1/UPPER MEMBER key words: shoulder, elbow, hand, fingers / sprain, tendinitis, pulled muscle, torn/stiff muscle, inadvertent movement, traumatology, inflammation, neuromuscular disease, sense-related disease, vascular disease, Raynaud's disease and LOWER MEMBER: toes, ankle, knee, hip /idem 2/BACK key words: lumbalgia, lumbago, sciatica, cervicalgia, dorsalgia 3/SKULL trauma, newborn cranial deformation, ear infection, sinus infection.

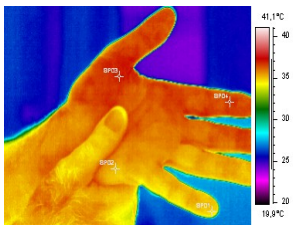
5 Experimentation and analysis

1 / Recording of prior tests

Thermal recordings of an artificial tissular compression before performing studies on patients, we performed mechanical compressions on ourselves:

thumb compression In the visible spectrum: the palm is firmly compressed; we immediately see a whitish zone upstream from the vascular dam, which corresponds to a lack of blood flow: primarily arterial.

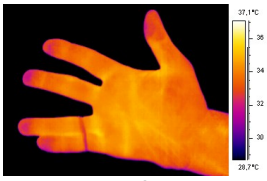
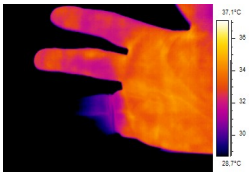
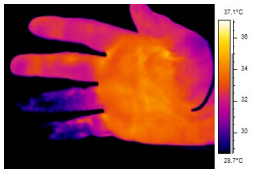
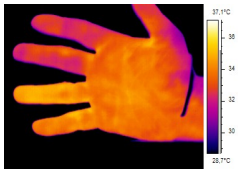
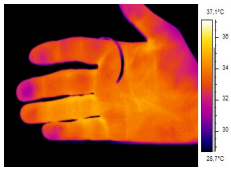





hand hand in infrared camera if we practice compression we observe thermal variations in infrared: there is a drop in temperature in the zone involved and in the dependent finger zone; skin cools

1.B / tissular compression with elastic band on fingers 4° and 5°, followed by removal of the compression

Palm view of a lengthy compression with an elastic band around the last two fingers of the right hand

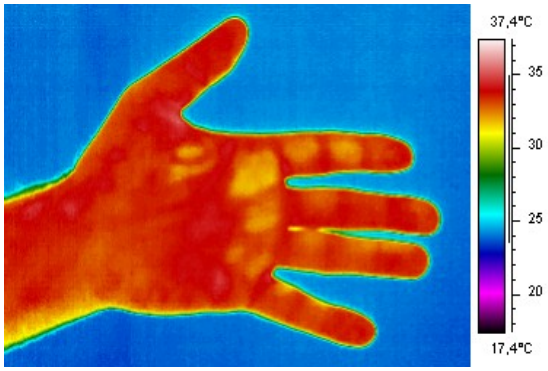
t= 0 t =+ 8 minutes liberation from elastic band t= +30 secondes t = +1min30sec

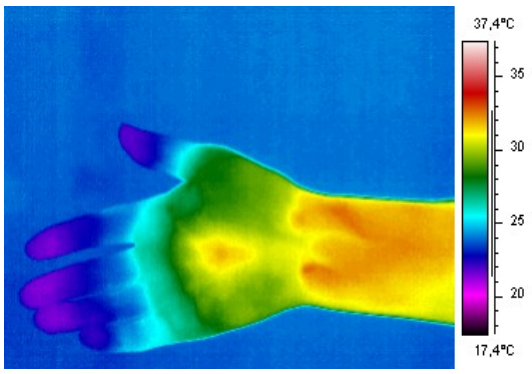
After 8 minutes of tissular compression: 10°C drop in temperature with respect to the initial thermal image. When the tissular obstacle is removed (i.e., when the elastic band is cut), vascular and thermal restitution is noted: 11°C rise in the previously constrained finger area. In fact, the entire hand participates in the thermal adaptation and modification that occurs after the barrier is removed; there is even hyperemia, and it takes more than a minute and a half for the hand to recover normal vascular and thermal functioning.

2 / Analysis of two types of dysfunction using the Thermovision camera

2.A / Trauma to the wrists

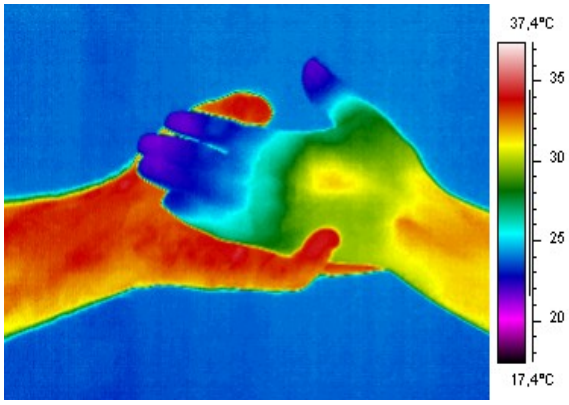
A 37 year-old female patient has trauma to both wrists. The trauma occurred more than 2 months prior during a martial arts examination and was treated with anti-inflammatory medication immediately following the incident.



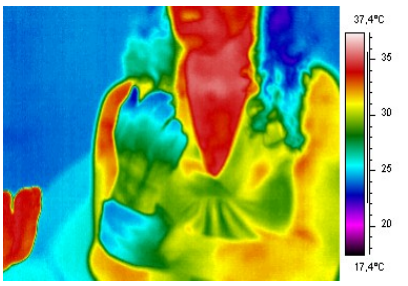


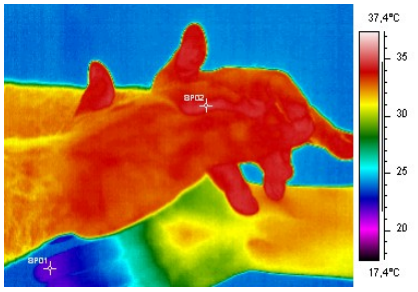
The practicing osteopath's hand The patient's right hand

Observation of the hand



Digital and radiometric analyses show the exact temperature at a precise spot:





The practitioner hand's coming on injury wrist: we can see the thermal radiation difference between the two hands before the ostepathic cure:
spot 1 = 21,5 °C spot 2 = 35,2 °C
The thermal difference is 13,7 °C.

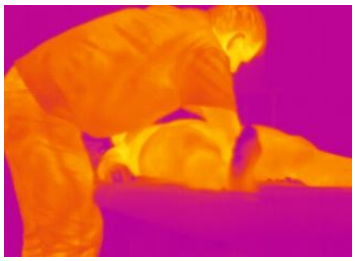
The patient complains of pain in her wrists Test of wrist tissue

TREATMENT: The osteopath performs an overall treatment (=Ttt) and a number of manoeuvres

Ttt upper member, lying down

Tttof a clavicular, thoracic and right pulmonary compression

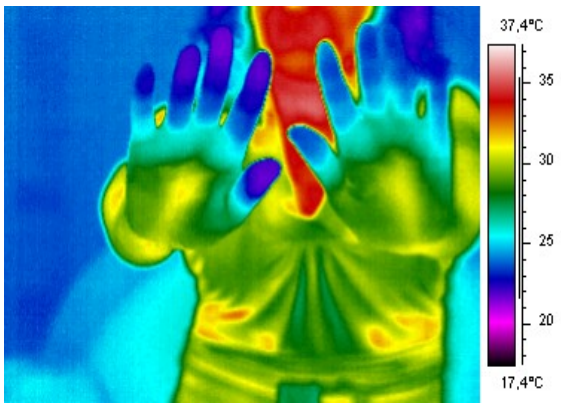
Ttt of a lumbar dysfunction

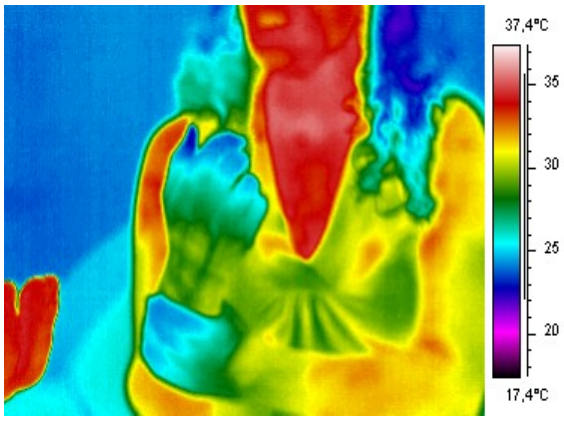


Craniosacral equilibrium: end of Ttt

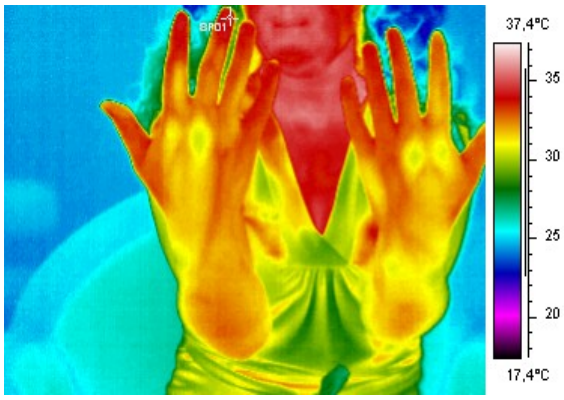
Thermal comparison

before osteopathic treatment



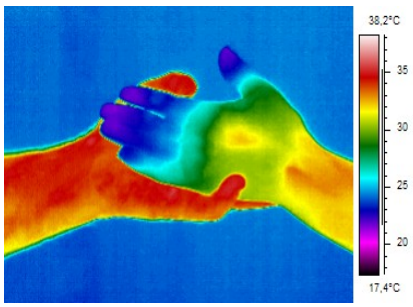


after



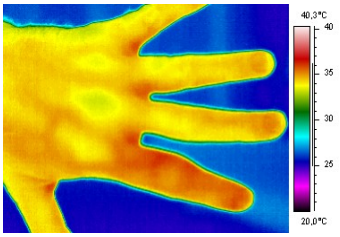
Eliminating tissular dysfunction makes revascularisation possible immediately after the treatment: thermal values rise from **21.5°C** to **34.5°C= spot 1**, a thermal differential of **+13.0°C.**

Thermal values of the image and radiometric analysis of the recording



DATA	23 AOUT 2008
OBJECT PARAMETERS	Emissivity 0,980
	distance 2,0 m
	reflected temperature 20,0°C
EXTERNE LOCAL	temperature atmosphere 21,0°C
EXTERNE OPTICAL	temp erature 20,0°C
	transmission 1,0
ATMOSPHERE	tempereture 20,0
	relativ humidity 50 %
	computed transmission 0,99
WINDOWS	bitmap bmp 404x240
	290 934 octets 24 bits
MODE ENREGISTRE	palet rain limits 37,4 – 17.4°C

2.B / Trauma and inflammation



The image show a post trauma finger inflammation (finger leaded and blocked by a rotary milling); forefinger inflammation is characterized by the local heat increase+red+swelling+pain.
The inflammations are tissues malfunctions; the per os anti inflammation cure is sufficient, no osteopathic test allow or global cure at the moment. The osteopathic correction will take place one month later ; the cure priority is the inflammation itself.

RESULTS

The osteopathic treatment carried out for each patient is global: cranial, vertebral, visceral and peripheral. Radiometric analysis showed immediate thermal modifications of between +2°C and +5°C in general, and of up to +13.0°C in some cases, after an osteopathy session.
Radiometric response is higher in regions near important vascular (vein and artery) axes such as the sub-clavicular region. We pinpointed three types of dysfunction:

*** "compression"**, described by the patient as "stiff" tissue, which leads to a cooling of tissues nearby or farther away. The patient indicates that heat relieves the pain. This type of dysfunction represents 95% of all cases treated by osteopathy.

*** an "inflammatory" lesion** combines excess heat with redness, pain and swelling of tissues. This type of lesion is also clearly visible in IR. Osteopathic treatment did not resolve the problem here; anti-inflammatory medication did. Anti-inflammatory medication is clearly useful in this case because it rids the body of excess heat just like cold compresses and ice. The complementariness of medicinal and osteopathic treatment is also evident in such cases. Osteopaths may act after the inflammatory phase; this category represents 1% of cases treated.

*** lesions that combine "compression and inflammation "**at the same site account for 4% of cases treated. The decompressing treatment is effective and reduces the inflammatory process straightaway.

DISCUSSION

Blood circulation is vital to human health. Dysfunctions in the circulatory system always go hand-in-hand with pathologies, whether they are causes or consequences of the latter. Two characteristics of blood circulation can be perceived: temperature and colour of irrigated tissues. We chose these parameters to examine dysfunctions in detail: either their appearance / presence or their attenuation / elimination.
A thermographically recorded osteopathy session for each patient showed immediate thermal variations: for the most part local and superficial hypothermia (back, neck, hand, abdomen, foot, thigh, etc.). Once the trauma barrier was removed, the flow of blood increased, causing an increase in the flow of transported heat***. In the near future, I hope to check the same patient 3 weeks later to analyse changes in state.
One important characteristic of osteopathy is that it produces immediate effects. Some trauma leaves a kinetic imprint in tissues, either locally as a result of a direct shock or through the accumulation of tension sometimes far from the zone to be treated. In fact, osteopaths often need to treat a tense zone not mentioned by the patient. Physical activity and climate change an individual's thermal values, as do some endocrinal, vascular and neuromuscular pathologies. We took these factors into account in doing our research, and were as a result particularly attentive to some of these illnesses. Patients often say they have a different thermal sensation at the end of a session. The 'objective' radiothermal image confirms their sensations and descriptions of problems: patients are reassured of the quality of their perceptions. Practitioners of osteopathy must also rely heavily on their senses, and cannot easily provide objective proof of their perceptions. Now, however, the effects of our actions can be viewed and quantified using radiometric technology and equipment: objective proof of thermal effects allows us to verify whether or not our actions correspond to the physiological effects desired.

CONCLUSION

Andrew Tailor Still was certainly right about the absolute role of the artery, as demonstrated by the thermal imaging camera, which provides significant research possibilities for osteopathy and has the advantage of making the invisible visible. We osteopaths know our treatments are effective in many cases; we know something about what is happening, but we also have a lot to learn about how our treatments work. Measurable thermal phenomena on the surface of the body immediately following an osteopathic treatment can be observed and recorded with a thermal radiometric camera. Osteopathic manoeuvres impact on vascular arterial and venous compressions associated with tissular anomalies and have a positive effect on hemodynamism and homeothermy; biomechanical, muscular and articular functioning are also modified and improved in a natural way. This thermal research has demonstrated the compressive and inflammatory nature of certain functional problems. The body can change remarkably to resolve problems and adapt. More experiments will be needed to confirm this research, establish new paths of investigation and offer solutions for a number of well-known and lesser-known medical pathologies.

« The rule of artery and vein is universal in all living beings, and the Osteopath must know that, and abide by its rulings, or he will not succeed as a healer. » .STILL A T : *Philosophy and Mechanical Principles of Osteopathy.* (1899) p. 153.