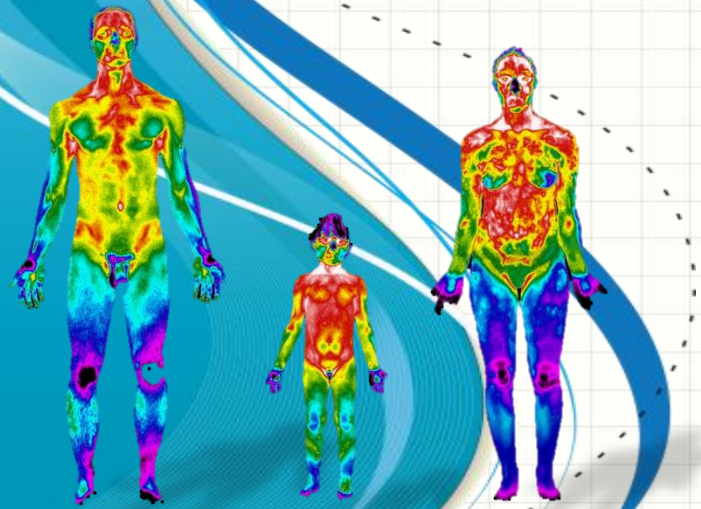
ABRATERM
Associação Brasileira de Termologia

THERMAL PATTERNS IN DISEASE AND CONDITION MONITORING



Prof Marcos Leal Brioschi MD PhD
São Paulo University, Brazil
Neurology Department, Pain Center
President of Brazilian Medical Thermology Association

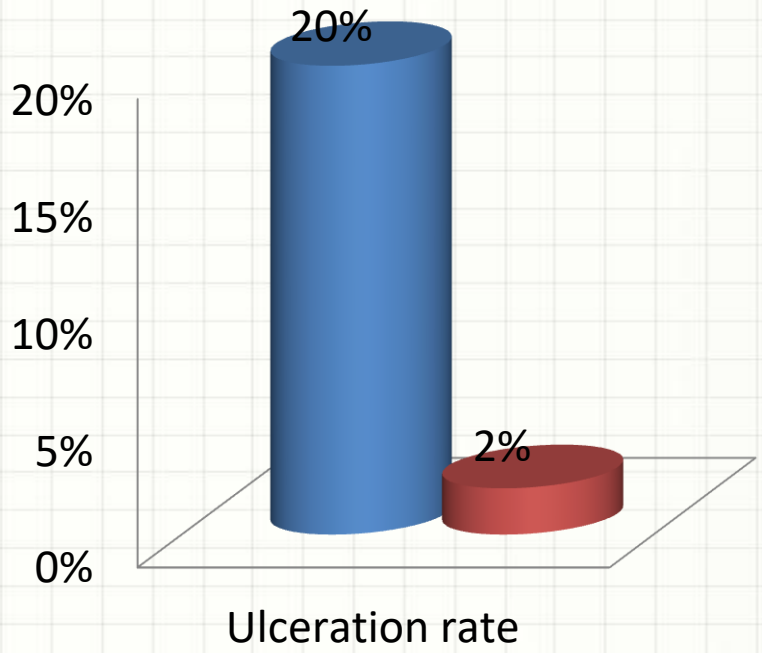
Saturday, September 16th
8:35am-9:20am-approximately 45 minutes

INTRODUCTION

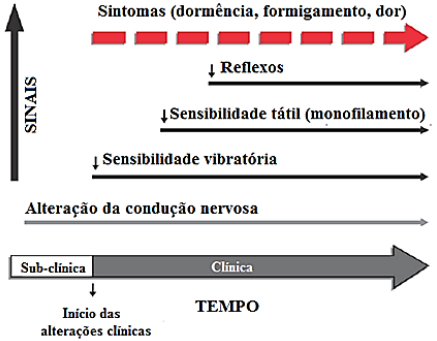
In 2016 we confirmed 3 key facts:

It is possible with IR definitively identify/map

- Neuropathies
- Polineuropathies
  - small fibers
  - reduce diabetic foot ulceration (predict/ prevent)
- Cold stress test can distinct from other neuropathies



BEDSIDE TESTS FOR NEUROPATHY



Total time 25 min ???

10 g monofilament - 1º, 3º, 5º toes and metatarses

Patient subjective feeling diminish the monofilament evaluation sensibility

Tactil sensibility

Pain sensibility

Vibratory sensibility

Very low sensibility (26% - 49%)

Clinical accuracy is VERY LOW

Table 4. Diagnostic Test Properties of Clinical Findings for the Presence of Abnormal Monofilament Examination Status*

Finding	TP	FP	FN	TN	Accuracy	Sensitivity	Specificity	LR Positive	LR Negative
Subjective sensations									
Burning	37	17	131	113	0.50	0.22	0.87	1.68	0.90
Numbness	83	27	85	103	0.62	0.49	0.79	2.38	0.64
Pain	43	20	125	109	0.51	0.26	0.84	1.65	0.88
Pins and needles	54	20	114	110	0.55	0.32	0.85	2.09	0.80
Foot asleep	43	19	125	111	0.52	0.26	0.85	1.75	0.87
Any of above 5	111	49	61	81	0.64	0.65	0.62	1.71	0.57
Age > 65 years, diabetes mellitus > 10 years, numbness, or male	145	98	27	32	0.59	0.84	0.25	1.12	0.64
Neurologic examination									
Ankle reflex	96	36	76	95	0.63	0.56	0.73	2.03	0.61
Pinprick	142	77	29	52	0.65	0.83	0.40	1.39	0.42
Position	34	2	135	126	0.54	0.20	0.98	12.9	0.81
Vibration	87	32	85	99	0.61	0.51	0.76	2.07	0.65
Any of above 4	160	92	12	38	0.66	0.93	0.29	1.31	0.24

**Abnormal monofilament status was defined as incorrect stimulus identification at any of 8 plantar sites on either foot. TP indicates true positive; FP, false positive; FN, false negative; TN, true negative; LR, likelihood ratios for positive and negative test results.*

Clinica evaluation has a poor performance for ulcer and amputation risk identification

Clinical Examination for the Detection of Protective Sensation in the Feet of Diabetic Patients – International Cooperative Group for Clinical Examination Research. J Gen Intern Med. 1999

But, temperature measurement is specific, objective, fast

HOW HOT IS YOUR FEET??

얼마나 뜨거운 당신의 피트 야 ??

DO YOU PRESCRIBE THERMOMETRY FOR YOUR DIABETIC FOOT PATIENTS?

Temperature Monitoring Directions

Each morning when you wake up (or shortly thereafter) please measure the temperature on the bottom of your feet. Using the provided digital thermometer measure the temperature at the following locations on both your left and right foot: big toe, ball of foot below the big toe, ball of your foot below your 3rd toe, ball of your foot below your 5th toe, the middle of your foot and the heel of your foot (see picture below). Record all temperatures in this diary. If the difference between any two corresponding sites on the left and right feet is more than 4° F, call the study team nurse (insert phone #) and reduce the time you spend on your feet that day. Do not resume your normal level of physical activity until the temperature difference reduces to a value less than 4° F.

Date: ____________________

	1	2	3	4	5	6
Left Foot						
Right Foot						
Difference						

Date: ____________________

	1	2	3	4	5	6
Left Foot						
Right Foot						
Difference						

Date: ____________________

	1	2	3	4	5	6
Left Foot						
Right Foot						
Difference						

Date: ____________________

	1	2	3	4	5	6
Left Foot						
Right Foot						
Difference						

Preventing Diabetic Foot Ulcer Recurrence in High-Risk Patients

Use of temperature monitoring as a self-assessment tool

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KEVIN R. HIGGINS, DPM[2]
DAN R. LANCTOT, BS[2]
GEORGE P. CONSTANTINIDES, MS[2]
RUBEN G. ZAMORANO, MSW, MPH[2]
KYRIACOS A. ATHANASIOU, PHD, PE[3]
DAVID G. ARMSTRONG, DPM, PHD[4]
C. MAULI AGRAWAL, PHD, PE[5]

identify early warning signs of the disease process is imperative to reduce the incidence of complications.

Inflammation is one of the earliest

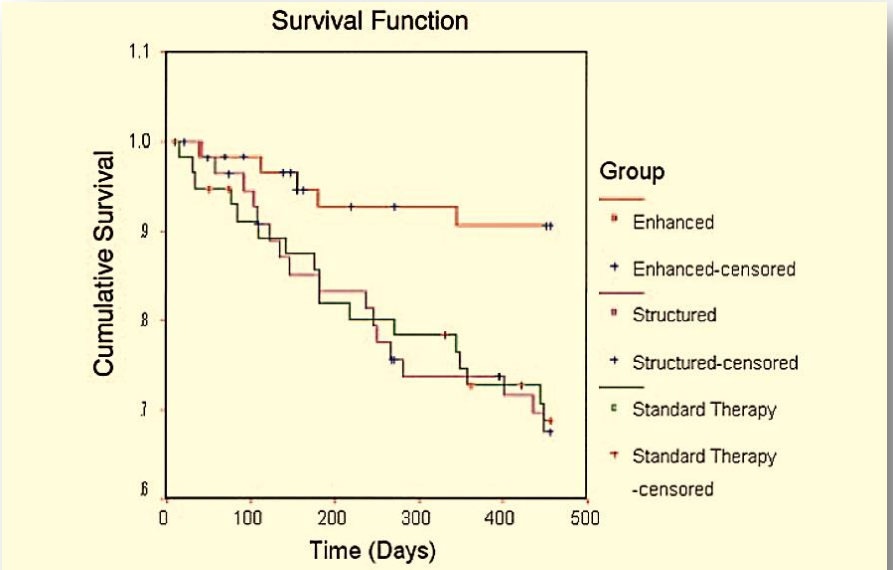
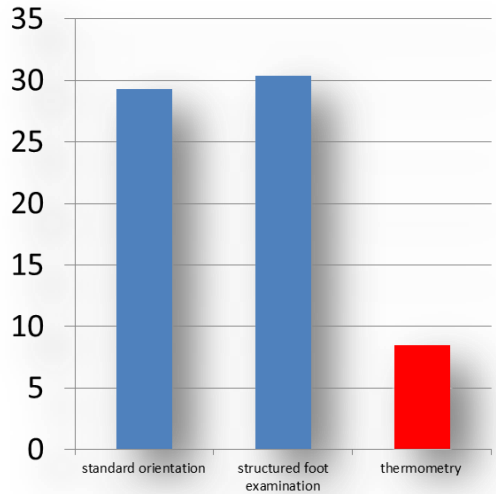


Figure 2—*Kaplan-Meier survival analysis of time to ulceration by treatment group. Kaplan-Meier survival analysis demonstrated a significantly longer time to ulcerate in the enhanced therapy group compared with the structured foot examination and standard therapy groups. The mean time to ulcerate was 429.5 ± 11.9 in the enhanced therapy group, 377.3 ± 18.4 in the structured foot examination group, and 378.5 ± 18.6 in the standard therapy group.*

- N = 173, monitoring 15 mo, multicenter
- Cut off point T > 2.2° C
- Developed ulcers:



- Standard orientation and structured foot examination had **4 times** more ulceration than without thermometry

***Diabetes Care* 30:14–20, 2007**
National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health

Foot ulcers and temperature monitoring

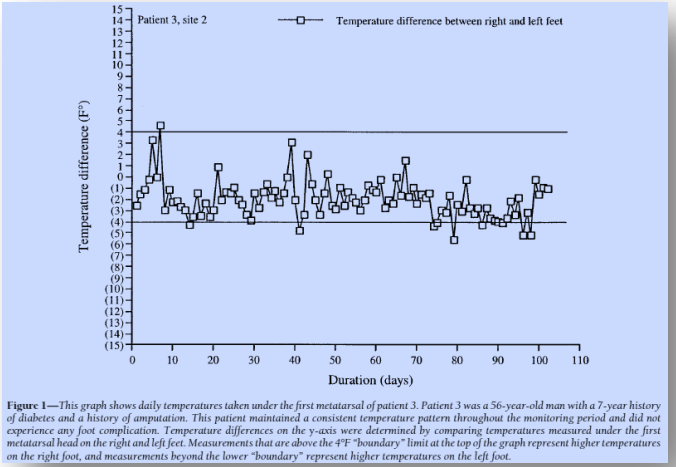


Figure 1—*This graph shows daily temperatures taken under the first metatarsal of patient 3. Patient 3 was a 56-year-old man with a 7-year history of diabetes and a history of amputation. This patient maintained a consistent temperature pattern throughout the monitoring period and did not experience any foot complication. Temperature differences on the y-axis were determined by comparing temperatures measured under the first metatarsal head on the right and left feet. Measurements that are above the 4°F "boundary" limit at the top of the graph represent higher temperatures on the right foot, and measurements beyond the lower "boundary" represent higher temperatures on the left foot.*

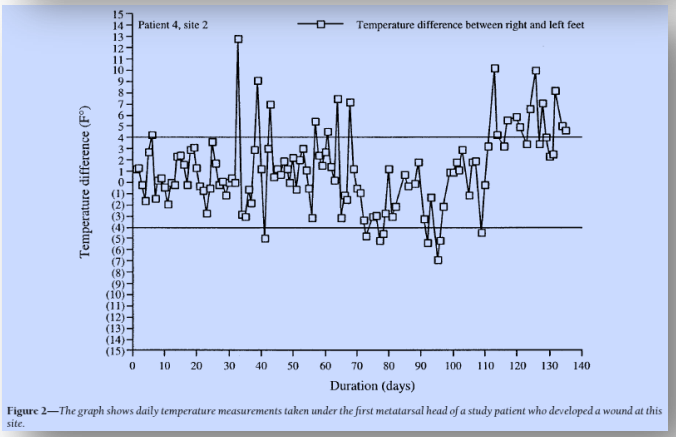


Figure 2—*The graph shows daily temperature measurements taken under the first metatarsal head of a study patient who developed a wound at this site.*

N = 85 (monitoring more than 100 d)

Controled randomized trial, blinded

Multicenter

Ulcerations:

2% Thermometry

20% Standart Therapy

(odds ratio 10.3, 95% CI 1.2-85.3)

- Standard therapý had **10 times** more ulceration than <u>without</u> thermometry

Lavery et al. Foot ulcers and temperature monitoring
DIABETES CARE 27(11), 2004

Houghton et al. Journal of Foot and Ankle Research 2013, 6:31
http://www.jfootankleres.com/content/6/1/31

JOURNAL OF FOOT AND ANKLE RESEARCH

REVIEW Open Access

Is an increase in skin temperature predictive of neuropathic foot ulceration in people with diabetes? A systematic review and meta-analysis

Vanessa J Houghton[1], Virginia M Bower[1,3*] and David C Chant[2]

Study ID	Effect	95% CI Lower	95% CI Upper
Armstrong 1997b	5.60	4.80	6.40
Armstrong 2007	2.76	2.48	3.04
Armstrong 1997a	4.50	2.74	6.26
Armstrong 2003	0.60	0.38	0.82
Armstrong 1996	6.90	5.30	8.50
Stess 1988	1.39	-3.24	6.01
Benbow 1994a	4.50	2.23	6.77
Benbow 1994b	-0.18	-2.16	1.80

Summary effect: 3.36 95% CI (1.86, 4.86)

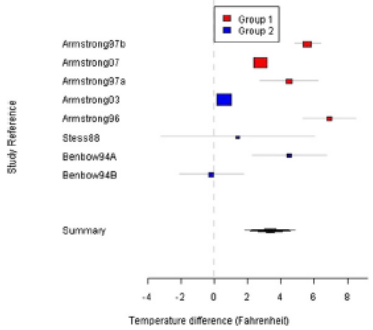


Figure 2 Random effects modelling of eight mean temperature differences in the "Effect" column (°F) and associated forest plot of observed mean temperature differences (°F, 95% CI) for groups "one" and "two".

Conclusions: The conclusions derived from this review are based on the best available scientific evidence in this field. It is intended that the results of this study will improve clinical decision-making and encourage the appropriate measures used to predict and prevent ulceration in people with diabetes at high risk of foot complications. Based on quality studies in this area, the results of this review have indicated that the use of temperature-monitoring is an effective way to predict, and thus prevent, diabetic foot ulceration.

DIABETES/METABOLISM RESEARCH AND REVIEWS
Diabetes Metab Res Rev 2012; **28**: X–XX
Published online in Wiley Online Library (wileyonlinelibrary.com) **DOI:** 10.1002/dmrr.DOI

REVIEW

Coming events cast their shadows before: detecting inflammation in the acute diabetic foot and the foot in remission

Manish Bharara[1]
Jeffrey Schoess[2]
David G. Armstrong[1]*

Summary

The incidence of diabetic foot complications, most notably wounds, is increasing worldwide. Most people who present for care of a foot wound will become

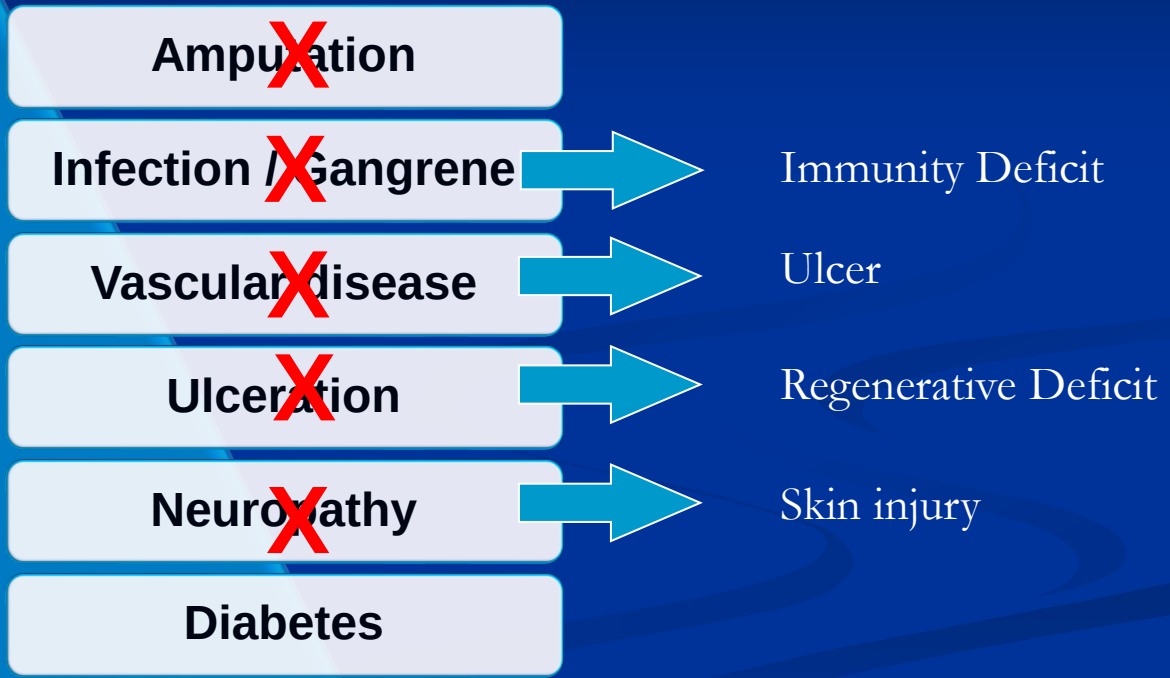
Table 2. Summary of the three randomized clinical trials demonstrating the effectiveness of handheld dermal thermometers

Study	Study design	Duration of study (months)	Ulceration control group (%)	Ulceration thermometry group (%)
Diabetes Care (2004)	RCT (85)	6	20	2
Diabetes Care (2007)	RCT (172)	12	29.3 and 30.4	8.5
American Medical Association (2007)	RCT (255)	15	12.2	4.7

RCT, randomized clinical trial.

Temperature monitoring for diabetes control is a fact!!

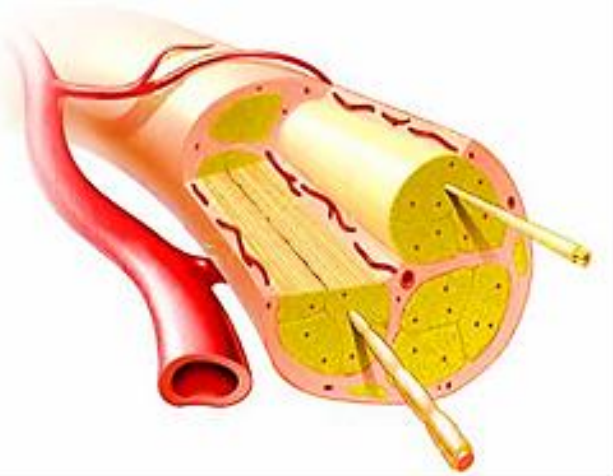
AMPUTATION PREVENTION

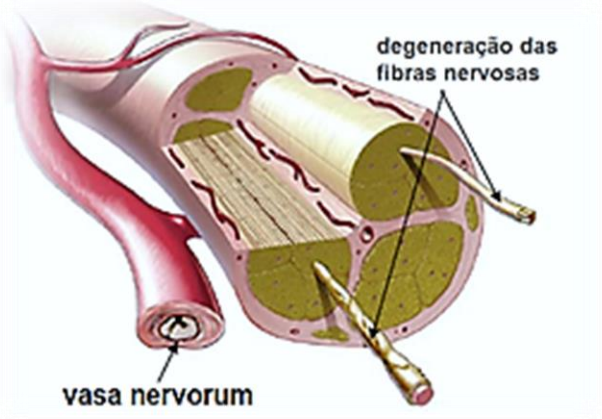


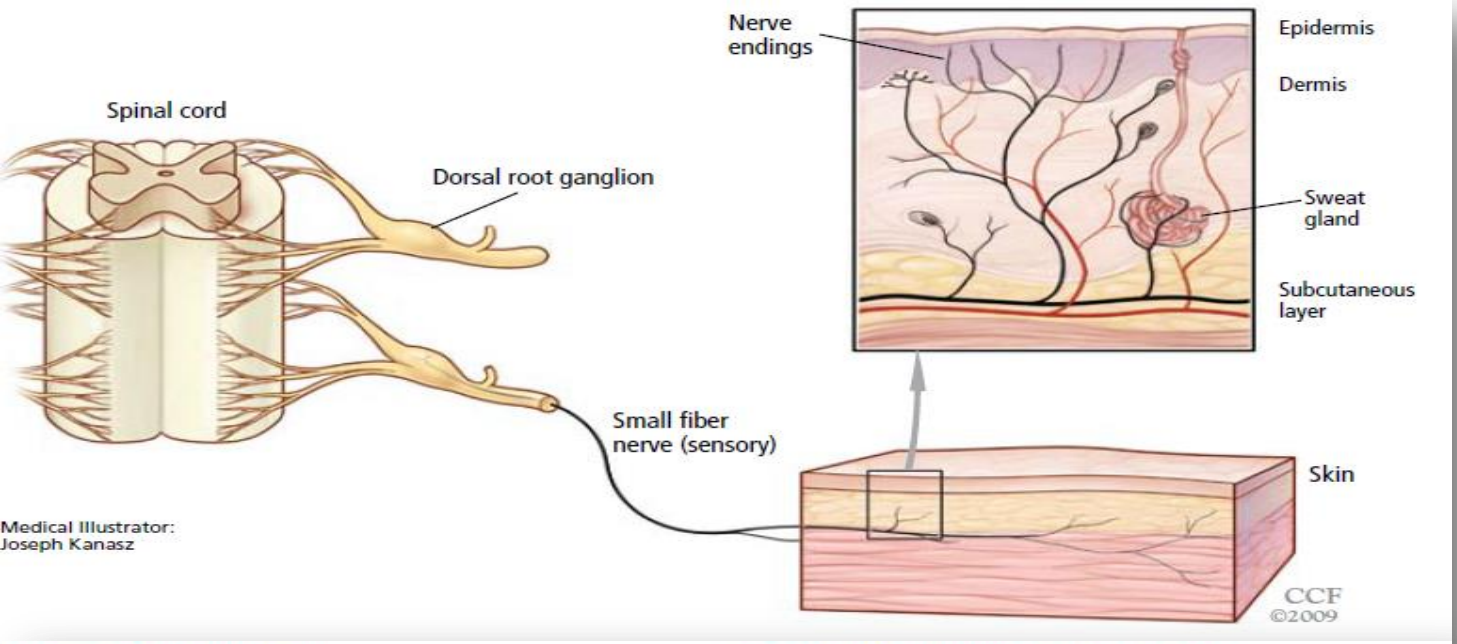
1. Lavery et al. Risk Factors for Foot Infections in Individuals With Diabetes. *Diabetes Care*. 2006;29:1288-93.
2. Dannels E. Neuropathic foot ulcer prevention in diabetic American Indians with hallux limitus. *J Am Podiatr Med Assoc*. 1989;79:447-50.
3. Mayfield et al. A foot risk classification system to predict diabetic amputation in Pima Indians. *Diabetes Care*. 1996;19:704-9.

Classification of Fiber Nerves

	Aα	Aβ	Aδ	C
Axônios da pele				
Axônios vindos dos músculos	Grupo I	II	III	IV
Diâmetro (μm)	13–20	6–12	1–5	0.2–1.5
Velocidade (m/s)	80–120	35–75	5–30	0.5–2
Receptores sensoriais	Proprioceptores do músculo esquelético	Mecanorreceptores da pele	Dor, temperatura	Temperatura, dor, prurido (coceira)







SMALL FIBER NEUROPATHY

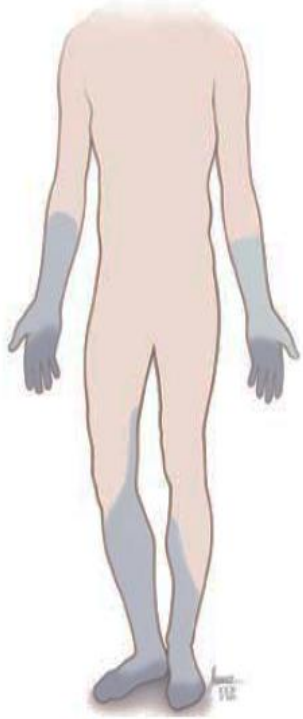
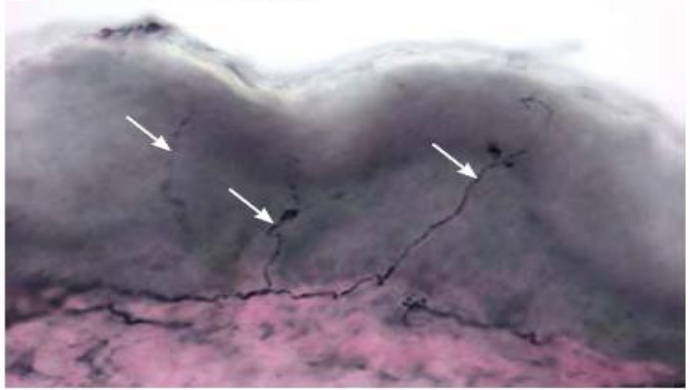
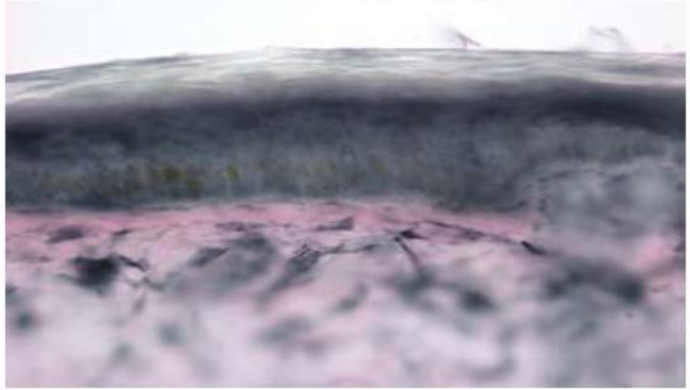


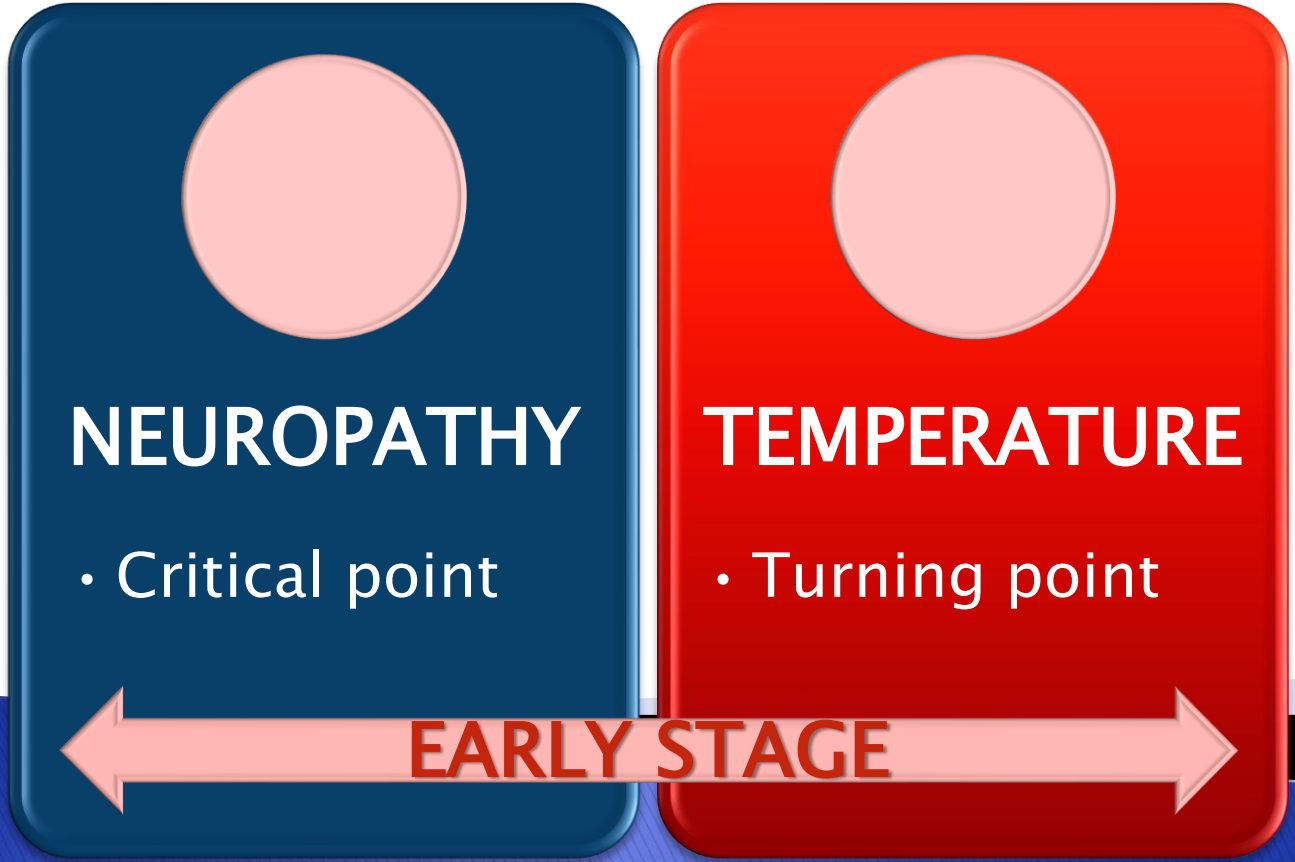
FIGURE 1. Symptoms are pain, burning, numbness, and autonomic dysfunction (lack of sweating) in the hands and feet in a stocking-glove distribution. Strength is not affected. Tendon reflexes are normal, as are nerve conduction studies.

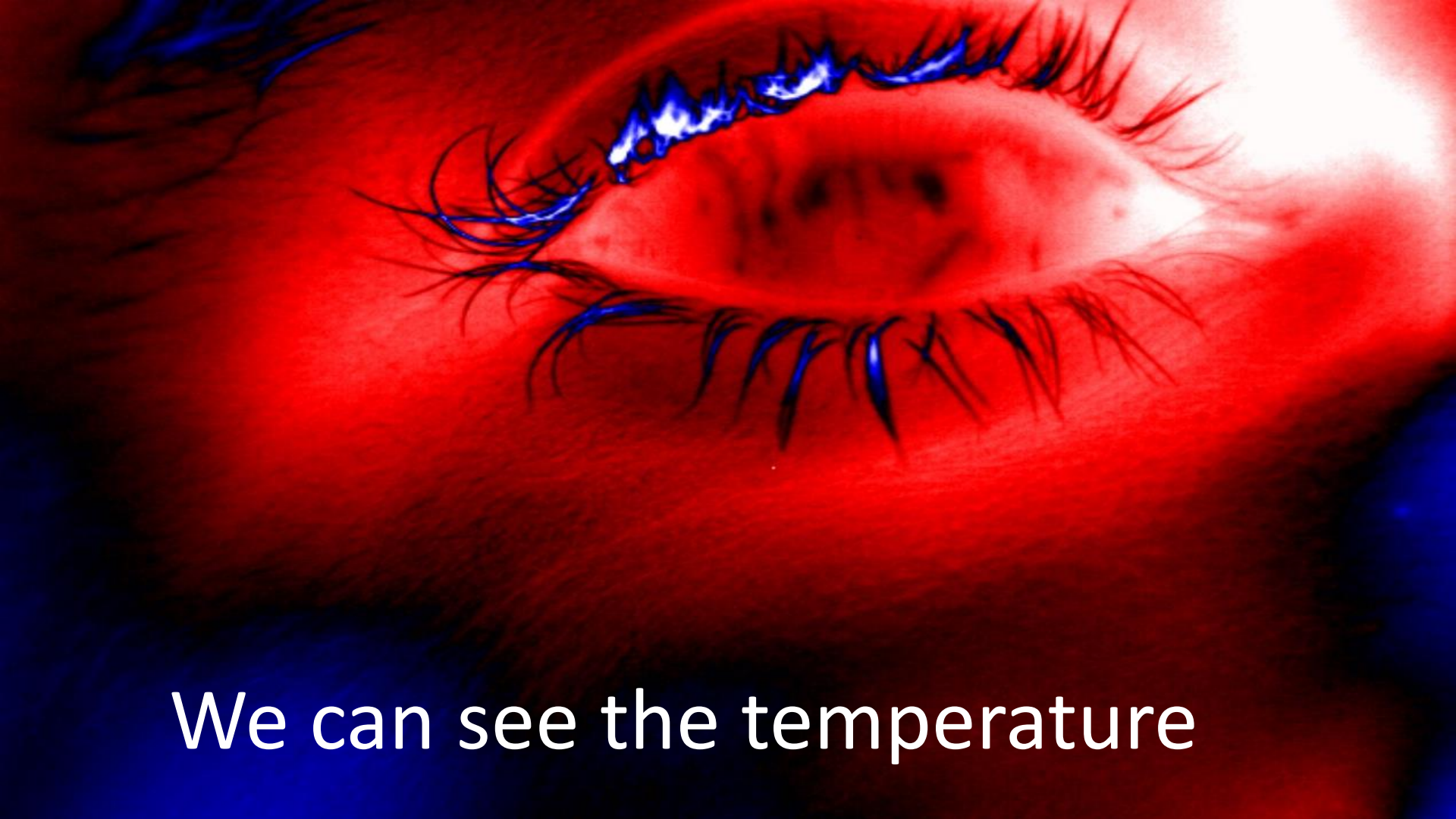
Normal skin biopsy



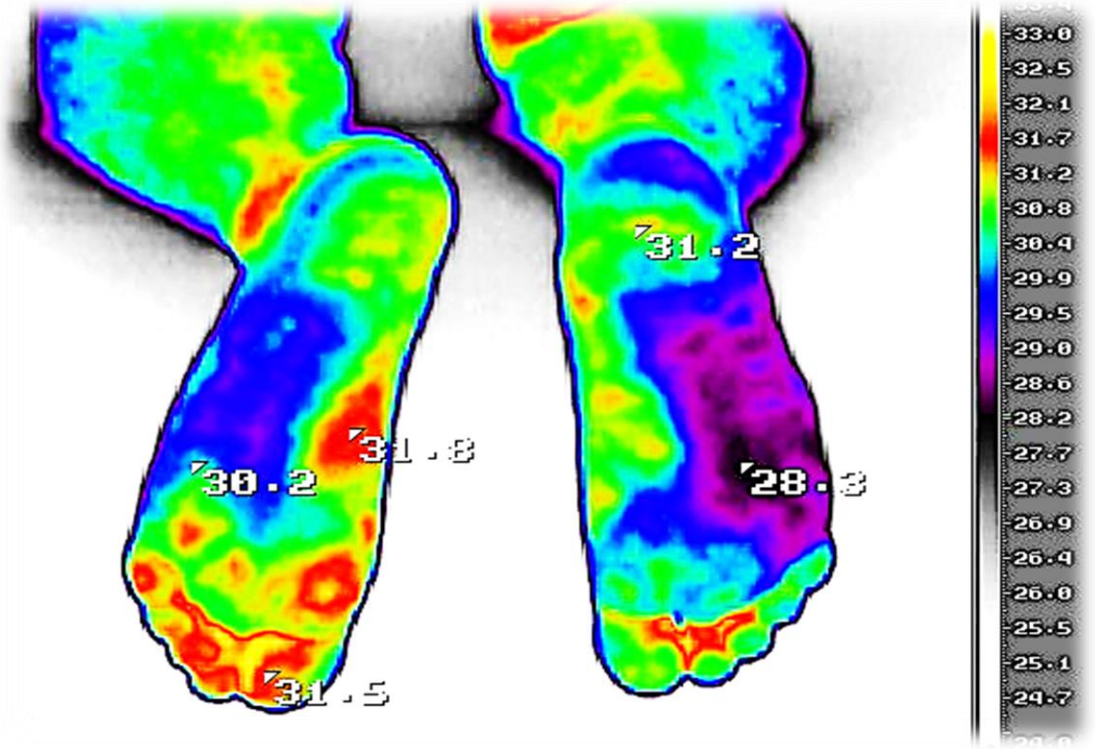
Small fiber neuropathy biopsy




NEUROPATHY
• Critical point
TEMPERATURE
• Turning point
EARLY STAGE


We can see the temperature

We can see the temperature


33.0
32.5
32.1
31.7
31.2
30.8
30.4
29.9
29.5
29.0
28.6
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27.7
27.3
26.9
26.4
26.0
25.5
25.1
24.7
31.2
31.8
30.2
28.3
31.5

13th Congress of the European Federation of Neurological Societies
EFNS 2009
Florence, Italy, September 12-15, 2009

UFRGS

UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
INSTITUTO DE CIÊNCIAS BÁSICAS DA SAÚDE
PROGRAMA DE PÓS-GRADUAÇÃO EM NEUROCIÊNCIAS

IBTeC

INFRARED COMPUTHERIZED THERMOGRAPHY IN THE EARLY DIAGNOSIS OF DIABETIC NEUROPATHY: PRELIMINARY STUDY

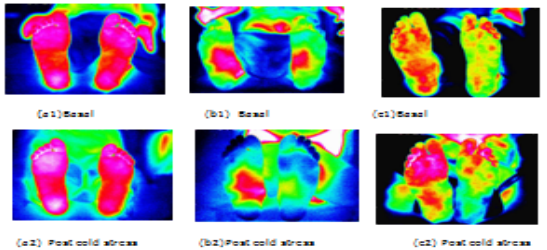
FIRST STUDY

Balbinot, L.F., Achaval, M.,Zaro, MA

Neurosciences Post Graduation Program, Morphological Sciences Department, UFRGS, Porto Alegre, Rio Grande do Sul, Brazil

OBJECTIVE

The present study had as proposal the application of Infrared Computherized Thermoography in the early diagnosis of diabetic neuropathy. It is known that the neuropathic disorders in diabetics include somatic manifestations and/ or of the autonomic nervous system, being, the autonomics the earliest. The thermography is a method of visualization and measuring of the emission of infrared radiation, which is proportional to the superficial temperature of the body, and which is related with the skin blood flow, mediated mainly by the sympathetic nervous system. Previous researches showed that the thermal mapping of the foot through thermography is capable of identifying and quantifying asymmetries and characteristic patterns of early autonomic dysfunction.



METHODS

In this early study, 10 subjects were evaluated (03 non-diabetics, 01 initial diabetic and 01 long-term diabetic), with thermography of the feet through the basal image and after maneuver of cooling. This is a non-invasive, non-ionizing and painless method, already validated by previous studies as a very sensitive means of diagnostic. Provocative maneuvers, such as the cooling of the feet, with later monitoring of the return to basal temperature were used by recommendation of previous studies to raise the sensitivity of the method.

AMERICAN DIABETES ASSOCIATION - ADA. Total Prevalence of Diabetes & Pre-diabetes (2007) [http://www.diabetes.org/diabetes-statistics/prevalence.jsp]. Acesso em 13/2/2008.
BALBINOT, LF et al. Avaliação e cuidados com pés diabéticos: associação de novos recursos visuais, como a Termografia Computadorizada por Infravermelho, Barogodometria, Preenchimento de zonas ulceradas por injeções e Calçados especiais para diabéticos. Tecnocouro. Jan 2009.
BOULTON, A.J.M. - Guidelines for diagnosis and outpatient management of diabetic peripheral Neuropathy. European Association for the Study of Diabetes. Neurodiab. Diabetes Metab. v.24 (Suppl 2), p.55-65, 1998.
SUNDKVIST, G.; ALMER, LO.; LILJA, B.Autonomic neuropathy and toe circulation.A prospective study. Acta Med Scand 1986, 219(2):205-209.
LOW, PA; VERMINO, S; SUAREZ, G.Autonomic dysfunction in peripheral nerve diseases. Muscle Nerve. v27, p646-661, 2003
YAGIHASHI, S; YAMAGISHI, S; WADA, R. Pathology and pathogenetic mechanisms of diabetic neuropathy:correlation with clinical signs and symtoms. Diabetes Res Clin Pract.v77 (Suppl 1) S184-S189, 2007.
ZOOTER, H; KERBL, R; GALLISTL, S; et al. Reversming index of the lower leg assessed by infrared thermography in adolescents with Type 1 Diabetes Mellitus. J Pediatr Endocrinol Metab 2003, 16 (2), p. 1231-1262

RESULTS

The qualitative evaluation of the thermographic images subjects was in accordance with the one found in the literature; in non-diabetics(a), symmetry, regular pattern of *hot* and *cold spots*, clear image of the fingers. The diabetics showed a reduced pattern of emission of Infrared, with abrupt variation of area more hot to cold, over the fingers or metatarsi distally, with greater asymmetry between the fingers of a same foot. The return to the basal temperature after cooling also showed to be slower in the non-diabetic subjects.

CONCLUSION

The results of this early study with small sample are in accordance with few scientific publications about the subject, which seems to be related with the microangiopathy and sympathetic autonomic neuropathy found in the diabetes mellitus.

Support: CAPES, CNPq.

Clinics cln-2012-0149 12/11/12 18:11:41

CLINICS 2012;67(12):1-7 DOI:

VALIDATION STUDY

CLINICAL SCIENCE

Plantar thermography is useful in the early diagnosis of diabetic neuropathy

Luciane Fachin Balbinot, Luis Henrique Canani, Caroline Cabral Robinson, Matilde Achaval, Milton Antônio Zaro

Universidade Federal do Rio Grande do Sul, Instituto de Ciências Básicas da Saúde, Laboratório de Histofisiologia Comparada, Porto Alegre/RS, Brazil.

OBJECTIVES: This study evaluated plantar thermography sensitivity and specificity in diagnosing diabetic polyneuropathy using cardiac tests (heart rate variability) as a reference standard because autonomic small fibers are affected first by this disease.

METHODS: Seventy-nine individuals between the ages of 19 and 79 years old (28 males) were evaluated and divided into three groups: control (n = 37), pre-diabetics (n = 13) and type 2 diabetics (n = 29). The plantar images were recorded at baseline and then minutes after a provocative maneuver (Cold Stress Test) using an infrared camera that is appropriate for clinical use. Two thermographic variables were studied: the thermal recovery index and the interdigital anisothermal technique. Heart rate variability was measured in a seven-test battery that included three spectral indexes (in the frequency domain) and four Ewing tests (the Valsalva maneuver, the orthostatic test, a deep breathing test, and the orthostatic hypotension test). Other classically recommended tests were applied, including electromyography (EMG), Michigan inventory, and a clinical interview that included a neurological physical examination.

RESULTS: Among the diabetic patients, the interdigital anisothermal technique alone performed better than the thermal recovery index alone, with a better sensitivity (81.3%) and specificity (46.2%). For the pre-diabetic patients, the three tests performed equally well. None of the control subjects displayed abnormal interdigital anisothermal readouts or thermal recovery indices, which precluded the sensitivity estimation in this sample of subjects. However, the specificity (70.6%) was higher in this group.

CONCLUSION: In this study, plantar thermography, which predominately considers the small and autonomic fibers that are commonly associated with a sub-clinical condition, proved useful in diagnosing diabetic neuropathy early. The interdigital anisothermal test, when used alone, performed best.

KEYWORDS: Thermography; Diabetic Neuropathy; Cardiac Autonomic Neuropathy; Small Fibers Neuropathy.

Balbinot LF, Canani LH, Robinson CC, Achaval M, Zaro MA. Plantar thermography is useful in the early diagnosis of diabetic neuropathy. Clinics. 2012;67(12):1-7.

Received for publication on June 30, 2012; **First review completed on** July 24, 2012; **Accepted for publication on** August 24, 2012

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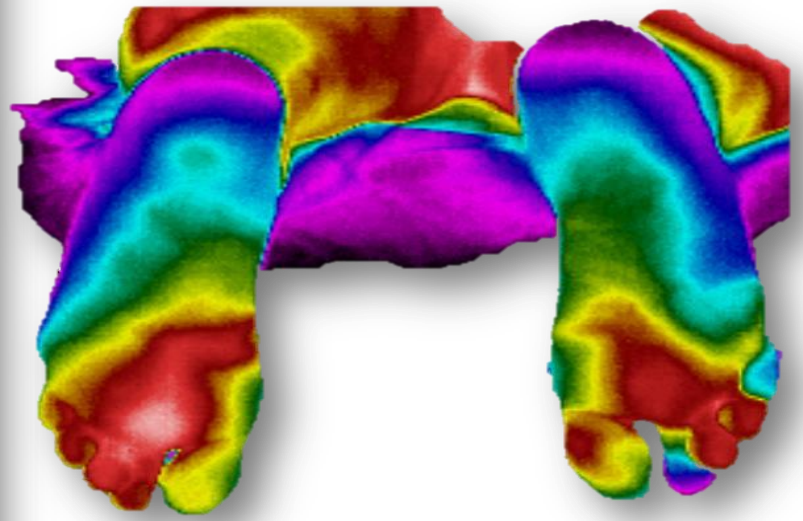
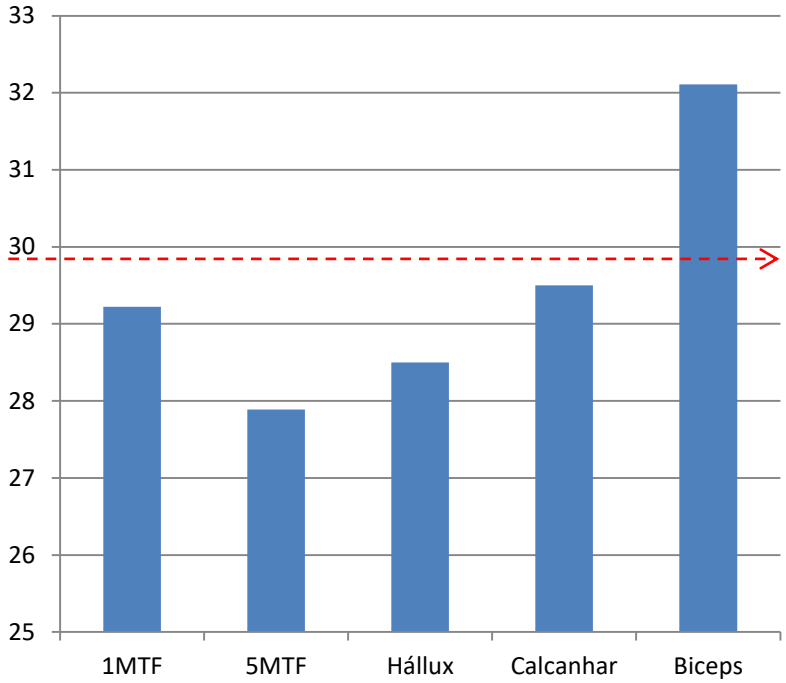
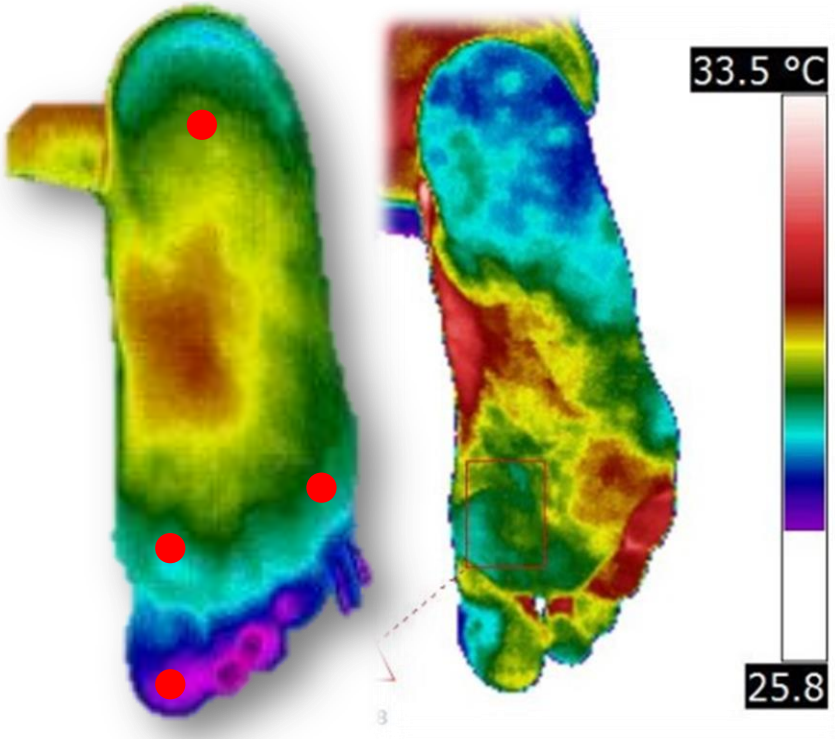
INTERDIGITAL ANISOTHERMAL TEST:

abnormal distal thermal gradient IR signatures



Normal Diabetic





FOOT

Butterfly pattern

Healthy control

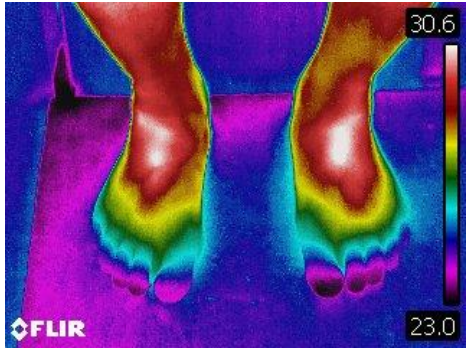
No vascular disease

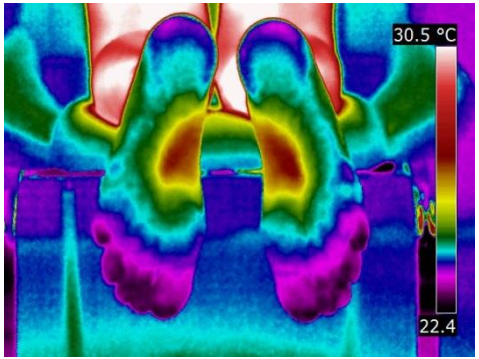
MORPHOLOGIC EVALUATION

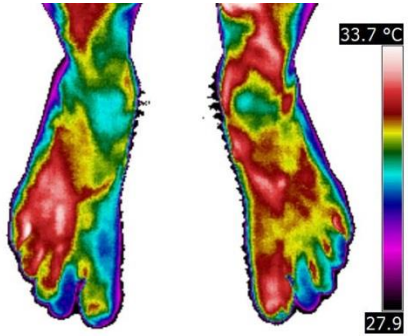
NORMAL

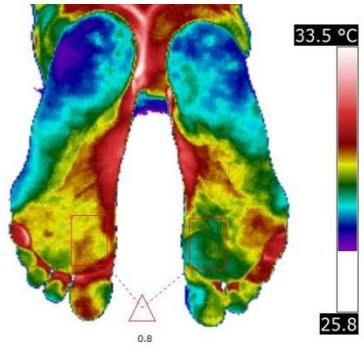
DIABETIC

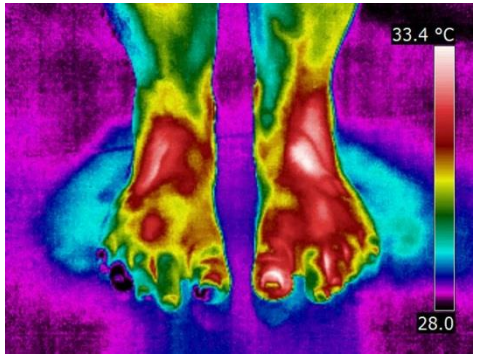
ANISOTHERMAL PATTERN

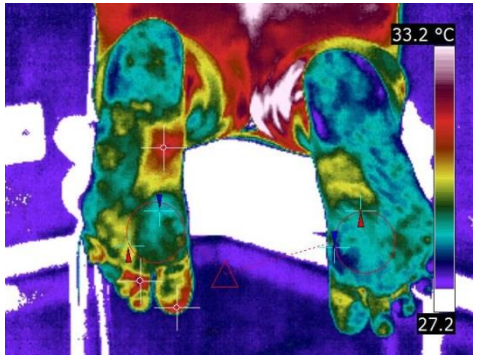


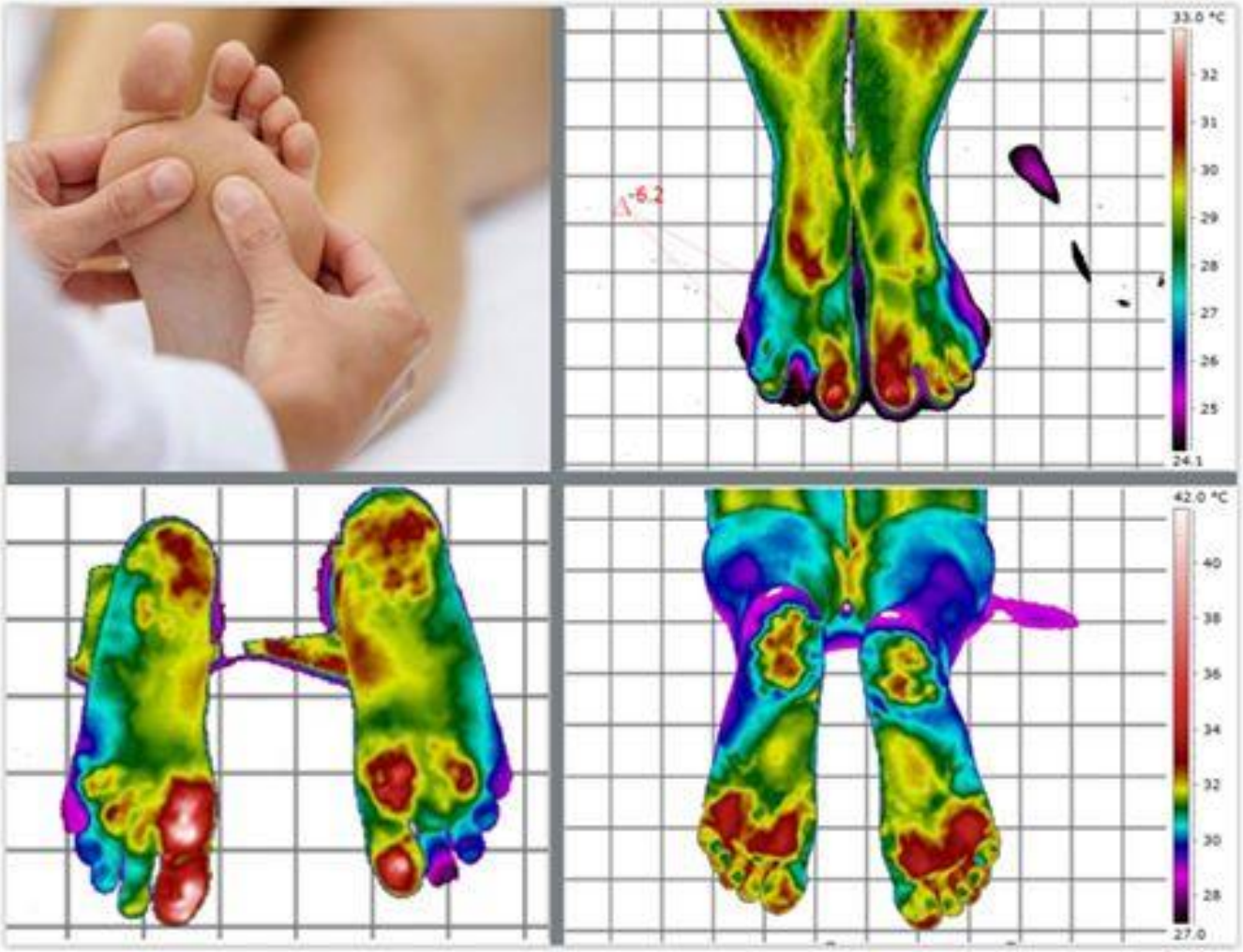


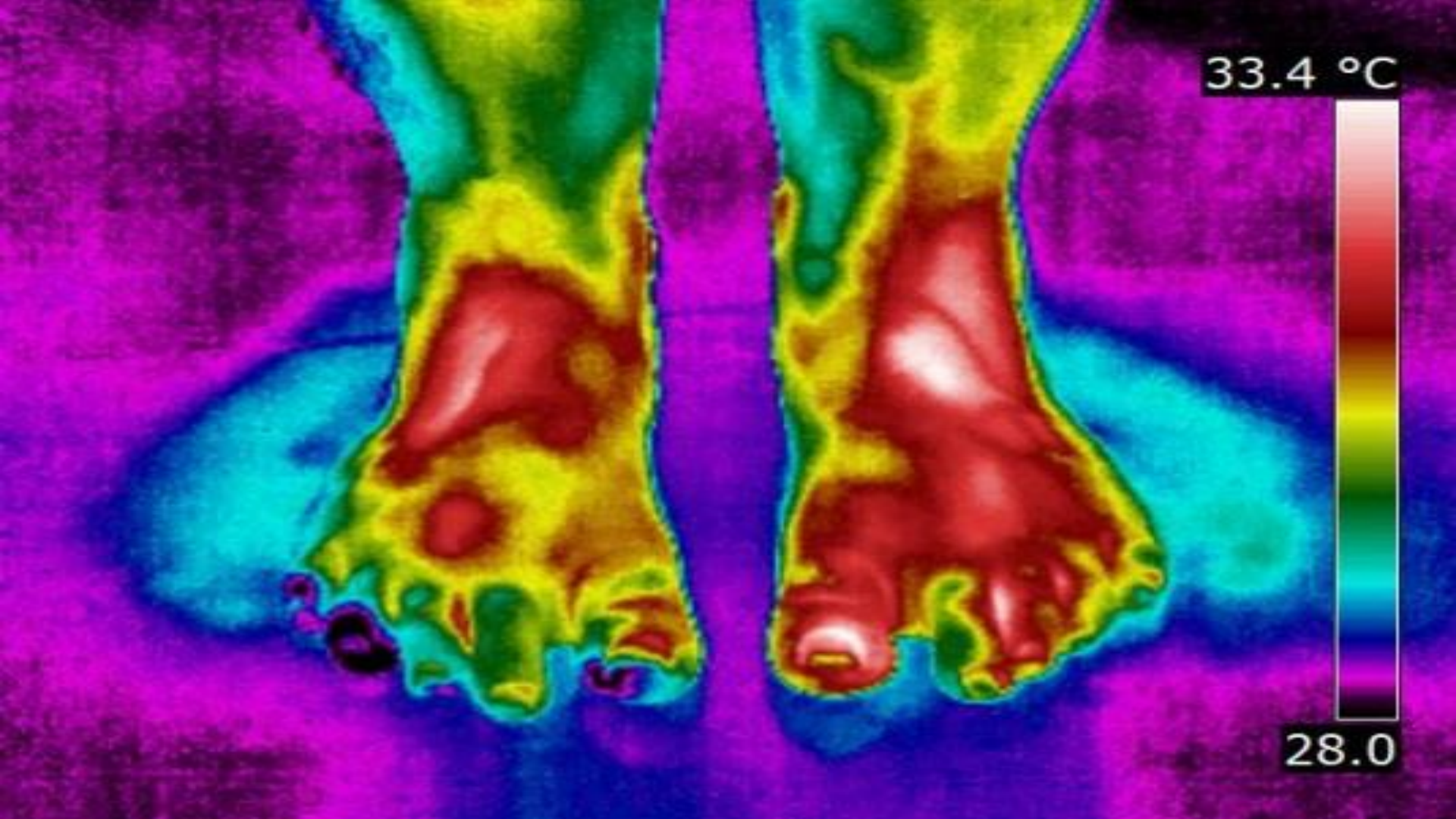


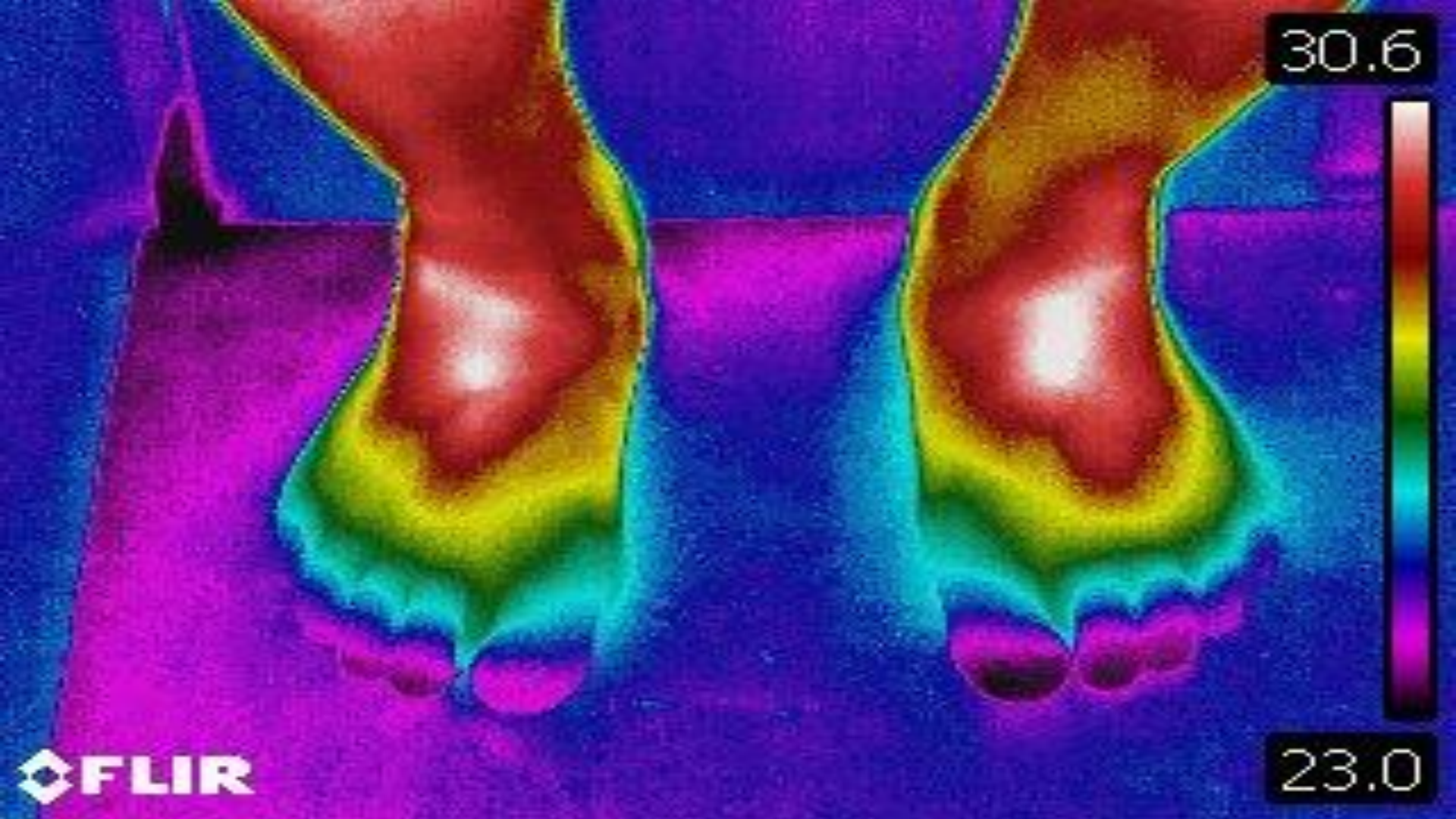


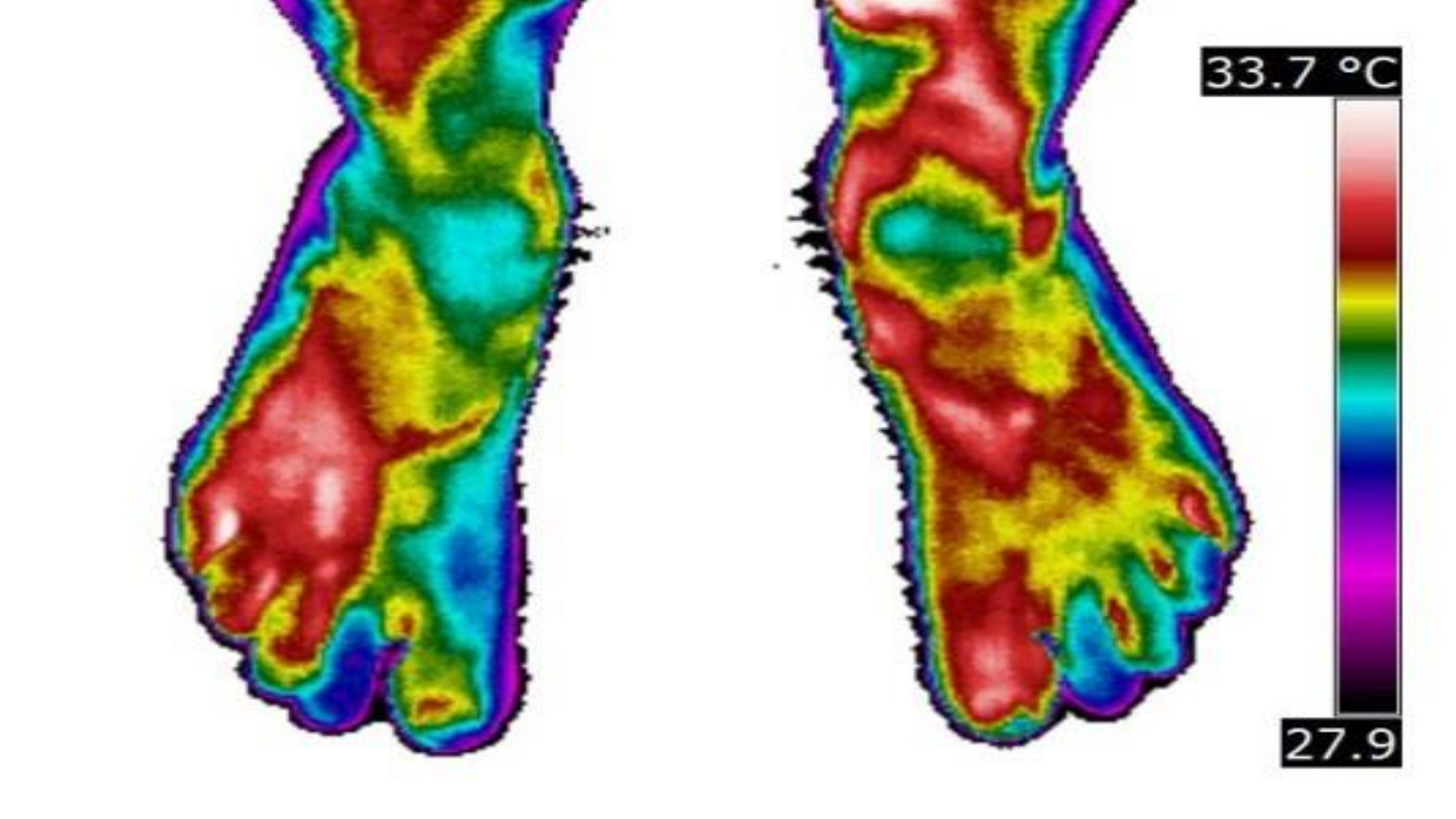


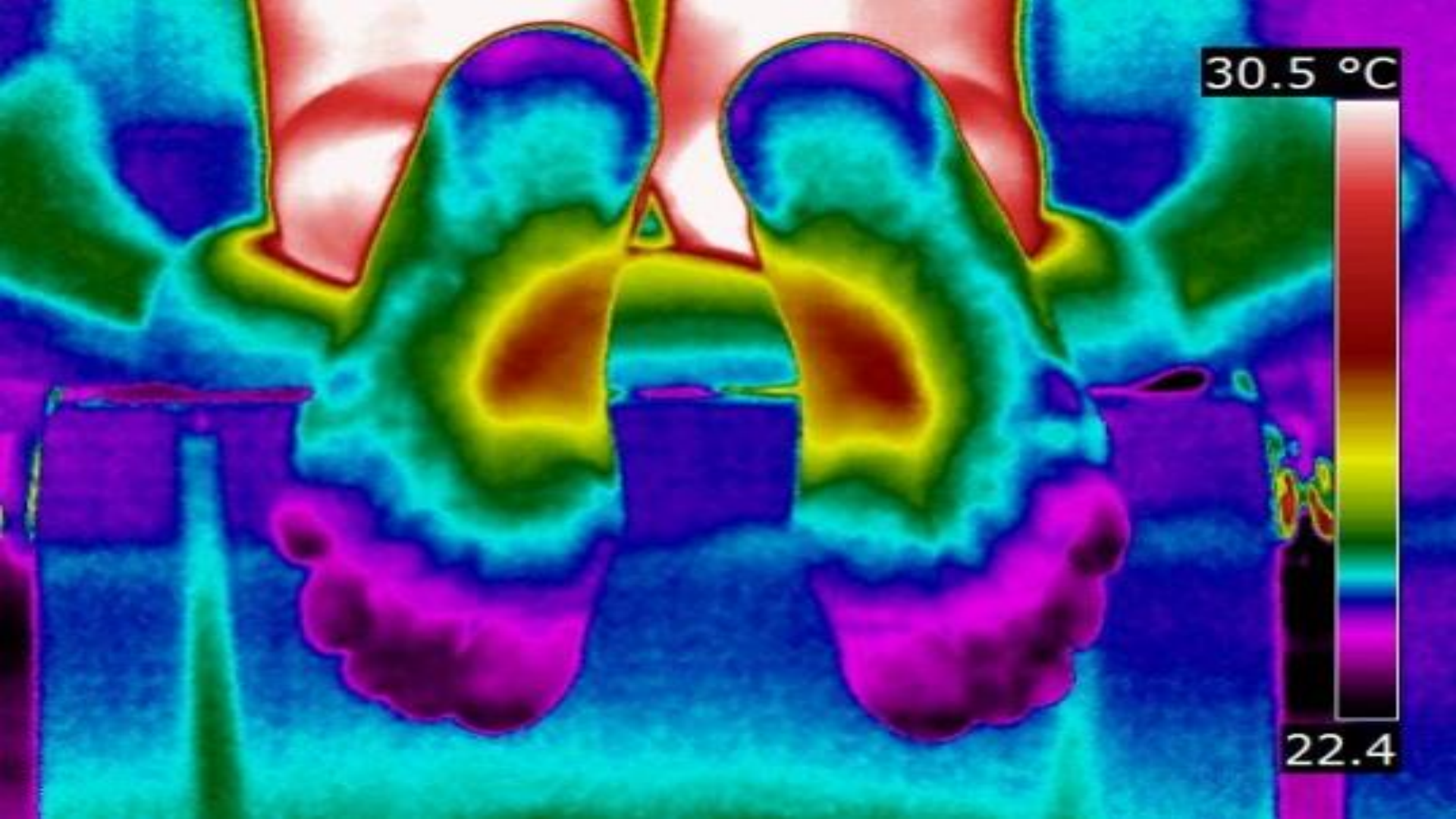


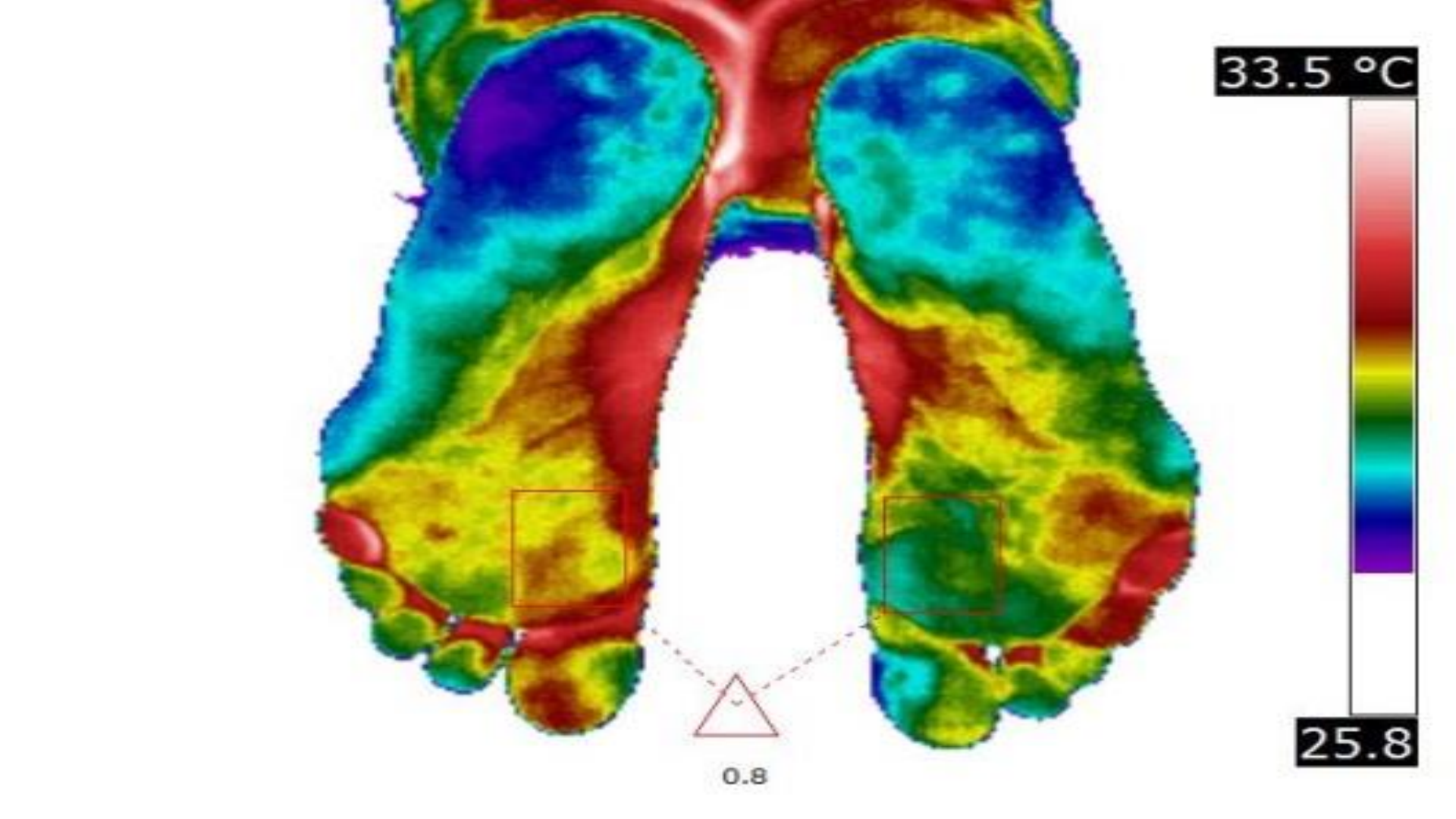

33.0 °C
32
31
30
29
28
27
26
25
24.1
42.0 °C
40
38
36
34
32
30
28
27.0

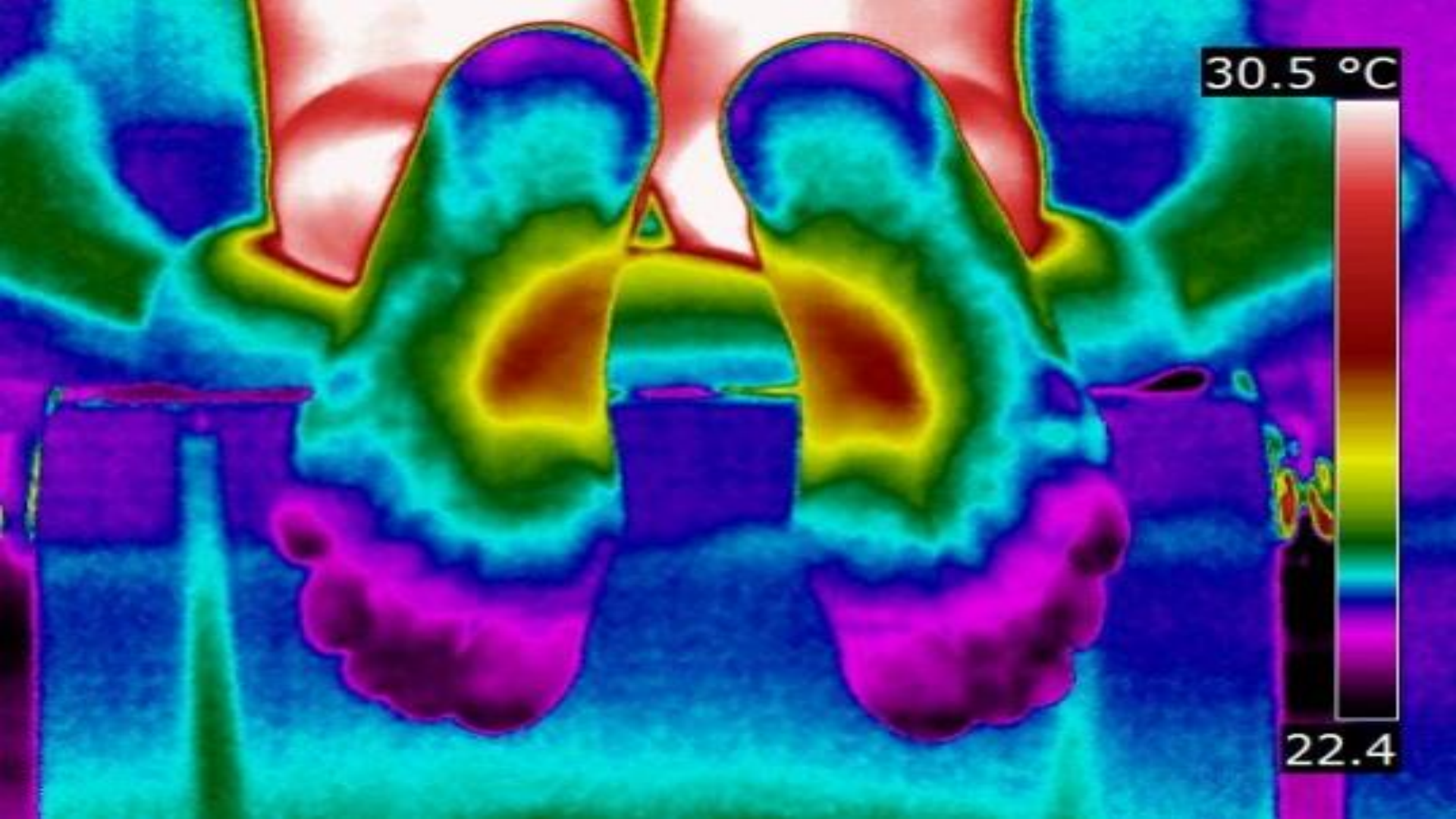

33.4 °C
28.0

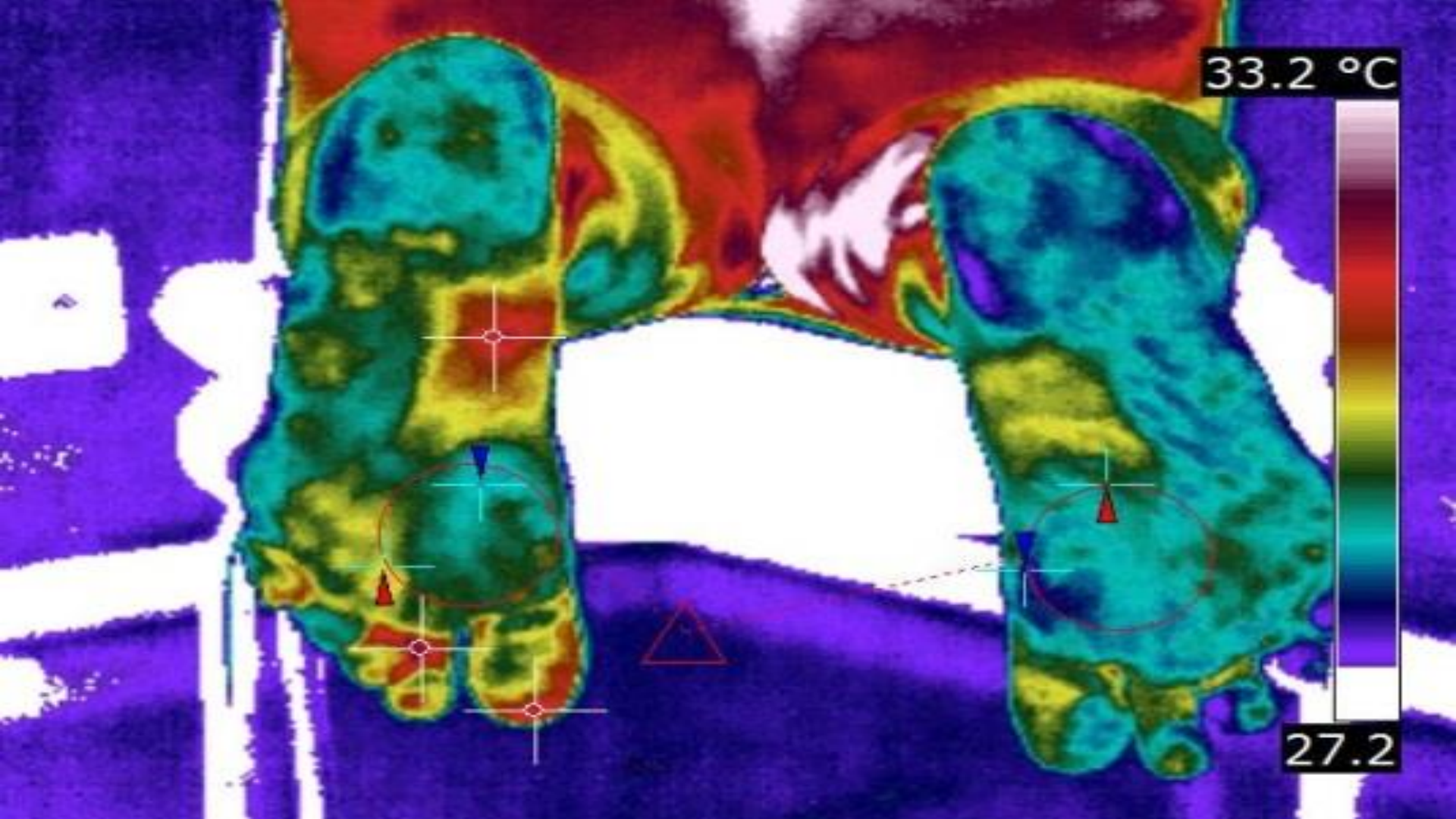

30.6
23.0
FLIR

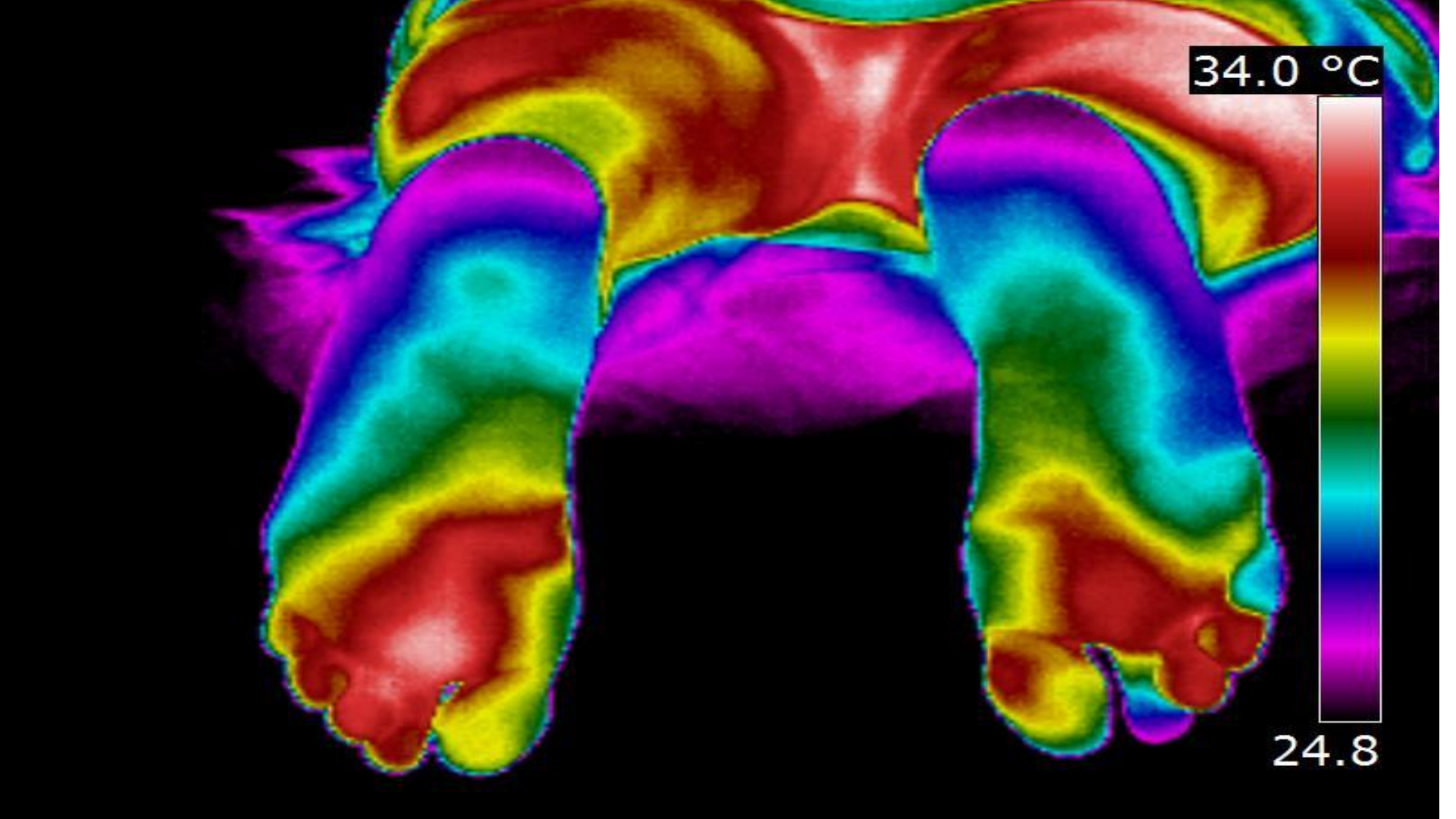

33.7 °C
27.9


30.5 °C
22.4


33.5 °C
25.8
0.8


30.5 °C
22.4


33.2 °C
27.2


34.0 °C
24.8

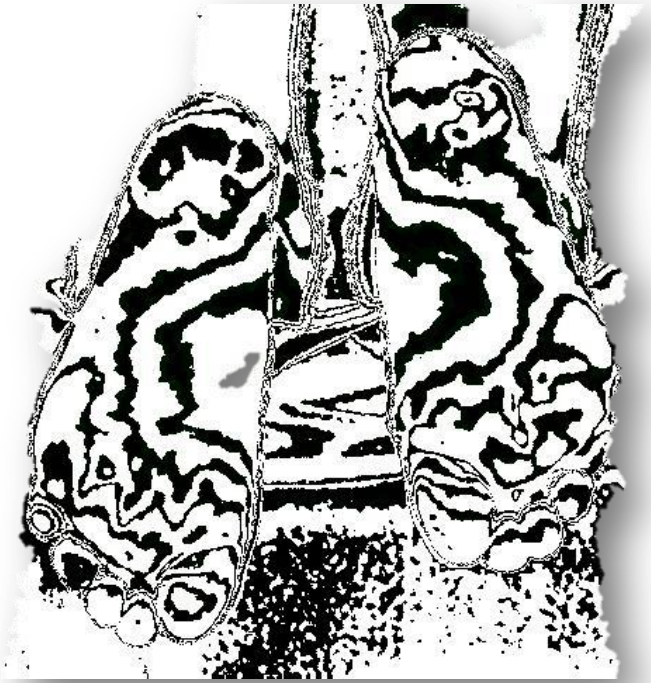

32.7 °C
24.5


35.0 °C
27.0

ANARCHIC PLANTAR THERMAL GRADIENT

Bilateral abnormal distal thermal gradient IR signatures

CntourRain10



Cntour12

ANARCHIC PLANTAR THERMAL GRADIENT

Bilateral abnormal distal thermal gradient IR signatures

- THERMAL DISTRIBUTION COME FIRST
  - Dont´worry with color scale (pallete)
  - Color scale is just for **intensity** measurement, not for diagnosis

THERMOGRAPHY IS EDUCATION FOR THE PATIENT

The amazing effect of seeing the problem:

- Image is easy for the patient to understand
- Help the doctor educate
- Patient becomes more proactive
  - Instead of the passivity of the clinical examination that does not see
- Greater adherence to treatment and guidelines
- More effective prevention

Journal of Diabetes Science and Technology
Volume 7, Issue 5, September 2013

REPRODUCIBILITY STUDY

SYMPOSIUM

Repeatability of Infrared Plantar Thermography in Diabetes Patients: A Pilot Study

Luciane Fachin Balbinot, M.D., Ph.D.,[1] Caroline Cabral Robinson, P.T., Ms.C.,[1]
Matilde Achaval, M.D., Ph.D.,[1] Milton Antônio Zaro, Ph.D.,[1] and Marcos Leal Brioschi, M.D., Ph.D.[2]

Abstract

Objective:

Infrared (IR) thermography has been used as a complementary diagnostic method in several pathologies, including distal diabetic neuropathy, by tests that induce thermoregulatory responses, but nothing is known about the repeatability of these tests. This study aimed to assess the repeatability of the rewarming index in subjects with type 2 diabetes mellitus (T2DM) and nondiabetic control subjects.

Journal of Diabetes Science and Technology
Volume 7, Issue 5, September 2013

SYMPOSIUM

Infrared Thermal Imaging for Automated Detection of Diabetic Foot Complications

Jaap J. van Netten, Ph.D.,[1] Jeff G. van Baal, M.D., Ph.D.,[1] Chanjuan Liu, M.Sc.,[2] Ferdi van der Heijden, Ph.D.,[2] and Sicco A. Bus, Ph.D.[1,3]

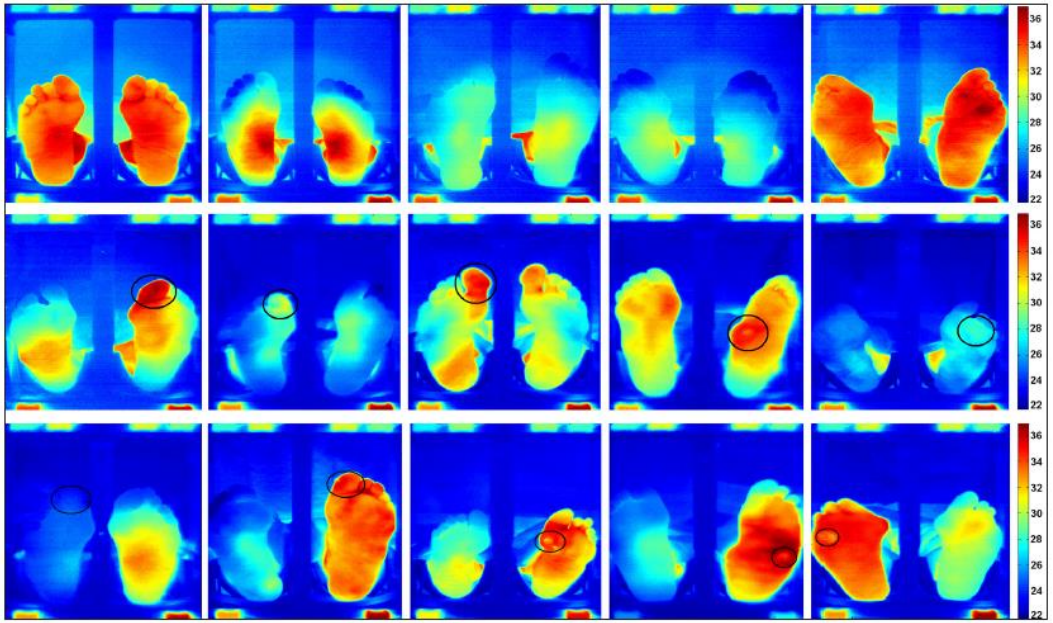
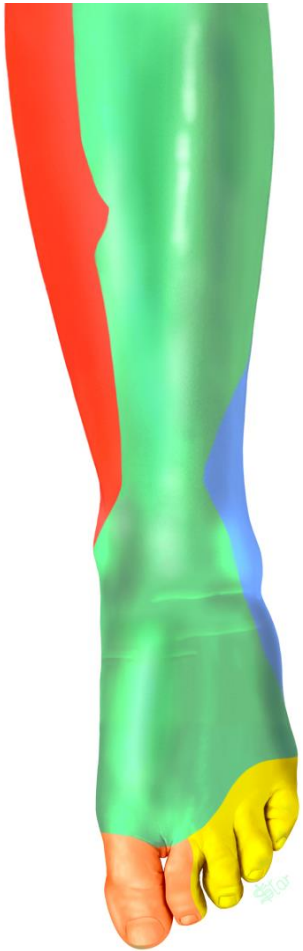
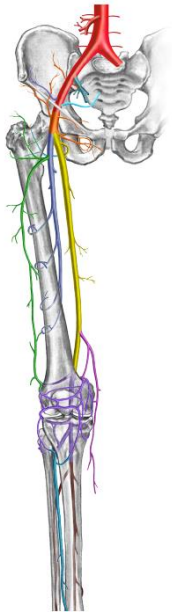


Figure 3. Thermal images of both feet of five patients without foot complications (top row, left to right, patients 1 to 5), five patients with local foot complications (middle row, left to right, patients 6 to 10), and five patients with diffuse foot complications (bottom row, left to right, patients 11 to 15). The ROIs are roughly indicated with black circles drawn on top of the image, actual ROIs were smaller and more precisely drawn. The six blocks shown along the perimeter in each image are the thermal references blocks.





Angiosomes Concepts

Sá Guimarães & Brioschi, 2017

THERMOPODOGRAPHY

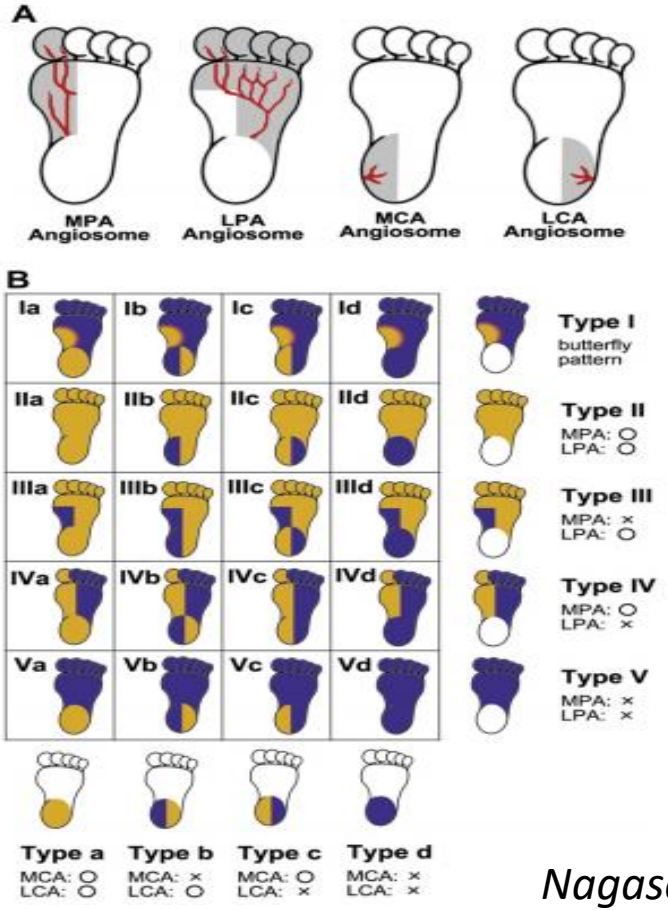


Figure 2 (A) Four plantar angiosome according to Attinger et al.[22] MPA: medial plantar artery. LPA: lateral plantar artery. MCA: medial calcaneal artery. LCA: lateral calcaneal artery. Note that the MPA angiosome and the LPA angiosome are overlapped in the hallux. (B) Conceptual classification of the plantar thermographic patterns with 20 different categories based on angiosome concept. MPA: medial plantar artery. LPA: lateral plantar artery. MCA: medial calcaneal artery. LCA: lateral calcaneal artery. Orange colour indicates higher temperature, and blue colour indicates lower temperature.

Butterfly pattern

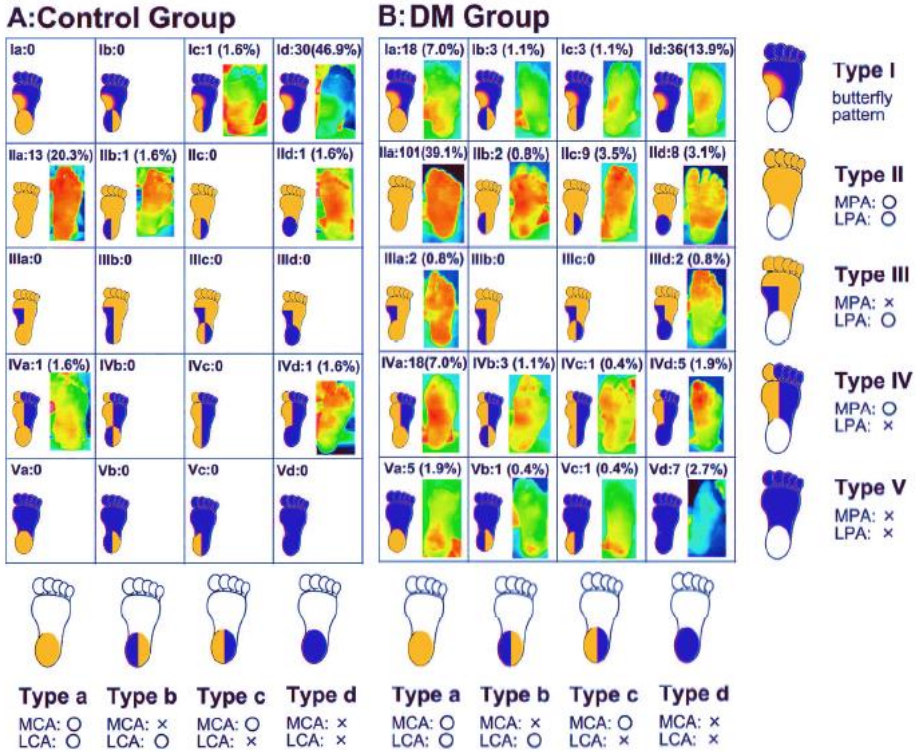
- Healthy control
- No vascular disease

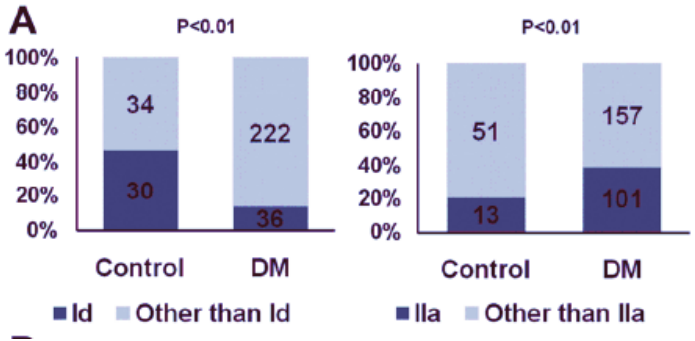
Type **Id** - Normal
Type **IIa** - DM

Nagase et al. J Plast Reconstr Aesthet Surg. 2011;64(7):860-6.

Screening of Foot Inflammation in Diabetic Patients by Non-Invasive Imaging Modalities

Takashi Nagase[1], Hiromi Sanada[1], Makoto Oe[1], Kimie Takehara[1], Kaoru Nishide[2] and Takashi Kadowaki[3]
[1]*Department of Gerontological Nursing/Wound Care Management Graduate School of Medicine, The University of Tokyo*
[2]*Department of Nursing, St. Marianna Medical University Hospital*
[3]*Department of Metabolic Diseases, Graduate School of Medicine, The University of Tokyo Japan*





Type **Id** - Normal
Type **IIa** - DM

Screening of Foot Inflammation in Diabetic Patients by Non-Invasive Imaging Modalities

Takashi Nagase[1], Hiromi Sanada[1], Makoto Oe[1], Kimie Takehara[1], Kaoru Nishide[2] and Takashi Kadowaki[3]
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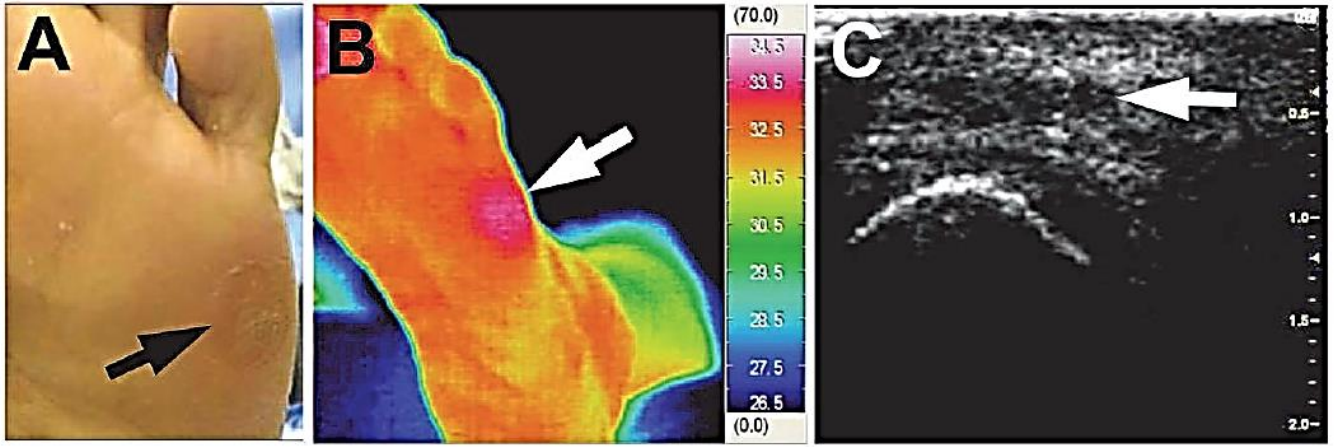
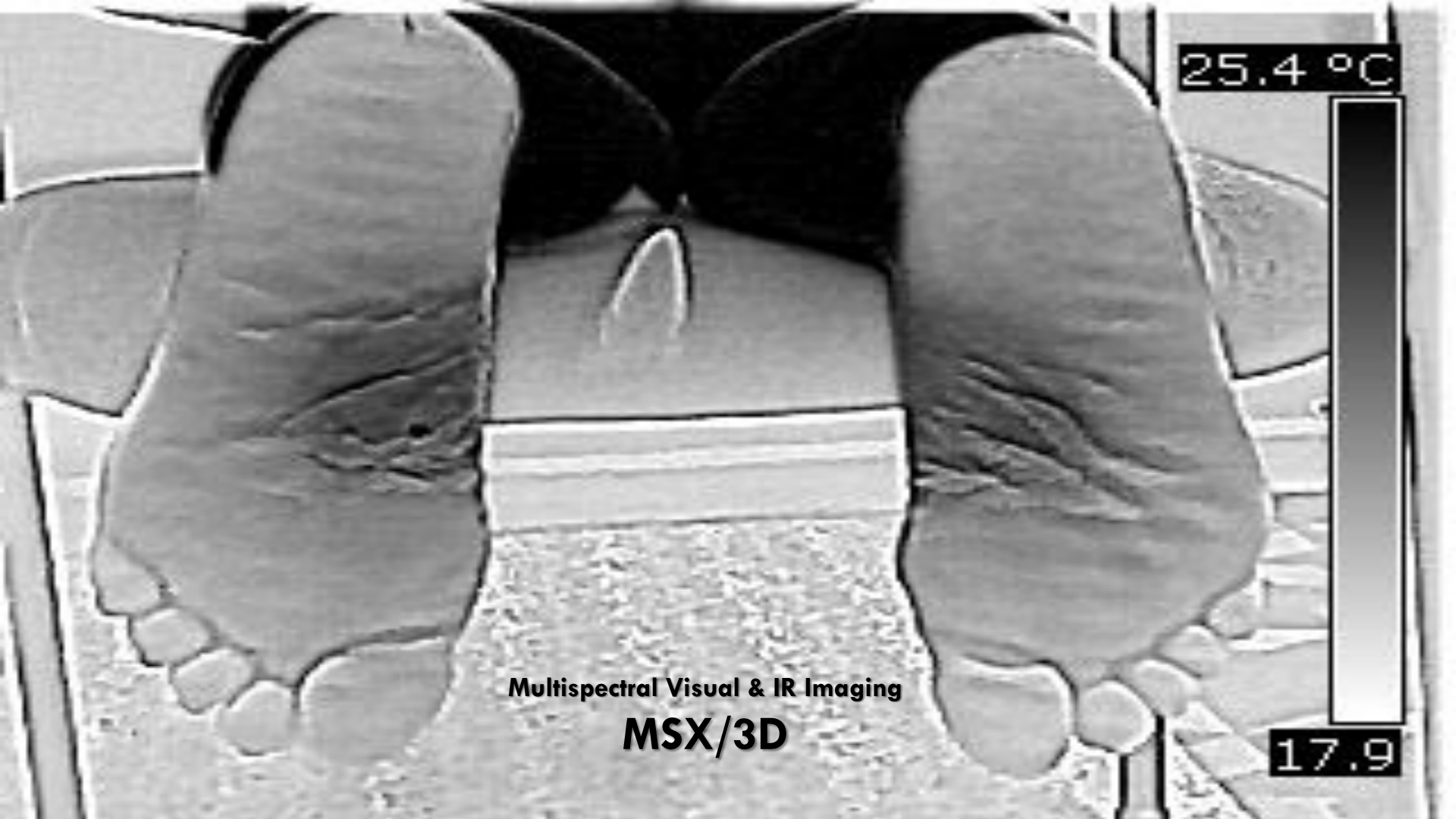


Fig. 5. An example of latent inflammation identified by thermography and ultrasonography. (A) Photograph. An arrow indicates the callus. (B) Thermography. An arrow indicates elevated temperature. (C) Ultrasonography. An arrow indicates low echoic lesion in the subcutaneous layer. Reprinted from Diabetes Research and Clinical Practice, Vol. 85 No.3. Nishide, K. et al. Ultrasonographic and thermographic screening for latent inflammation in diabetic foot callus. p.304-309, 2009. with permission from Elsevier.


25.4 °C
17.9
Multispectral Visual & IR Imaging
MSX/3D

Visual & IR fusion

Diabetic Foot Protocol

Future IR:
Ulcers <10%

> 90%
healing

Thermography

GDM e GPD=TODOS
GC= SUSPEITA

ENMG

Testes Cardíacos

Termografia plantar

Questionário

Contato Inicial
(TCLE)

Aquileo Reflex

Fingerboard 128 Hz

Semmes-Weinstein 5.07

Monofilament 10 g

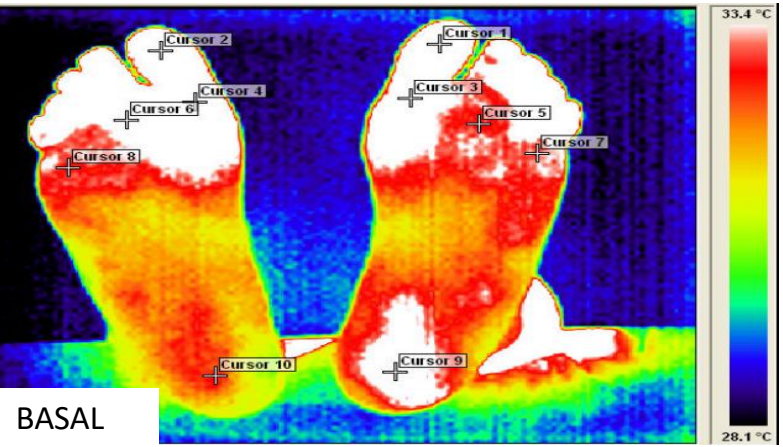
Today: Ulcers
>30%

2/3 healing

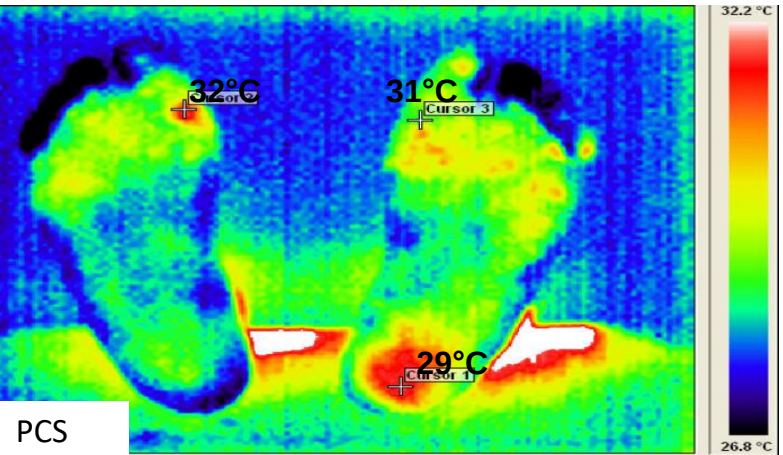
1/3
amputation

2/3 die
5 years

FEET OVERLOAD WITH ALTERED PLANTAR THERMOGRAPHY PATTERNS

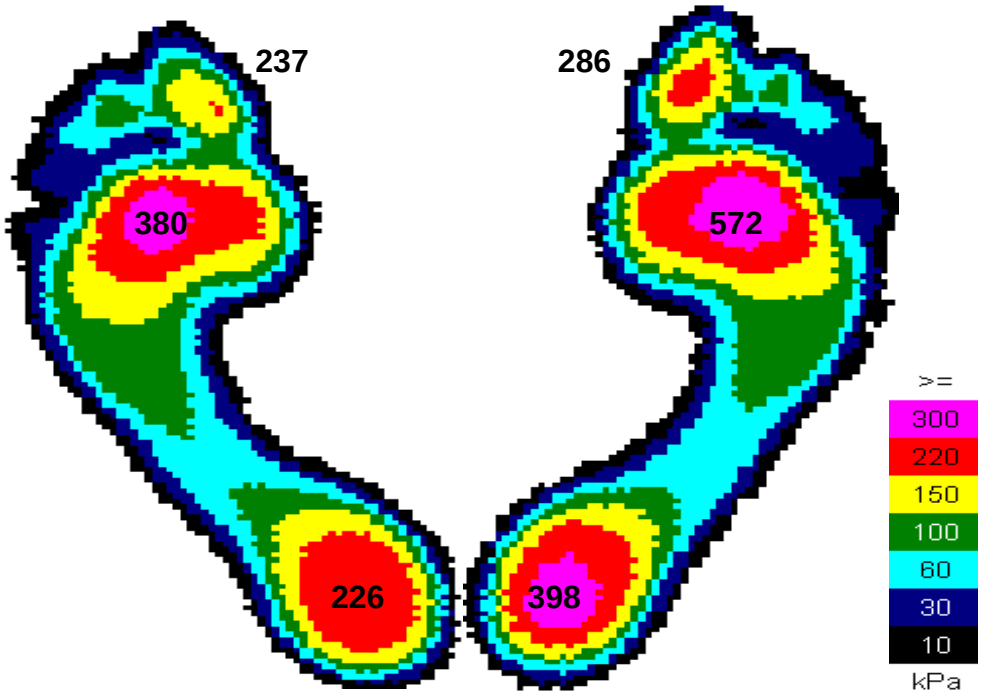


BASAL



PCS

Associated PEDOBAROGRAPHY



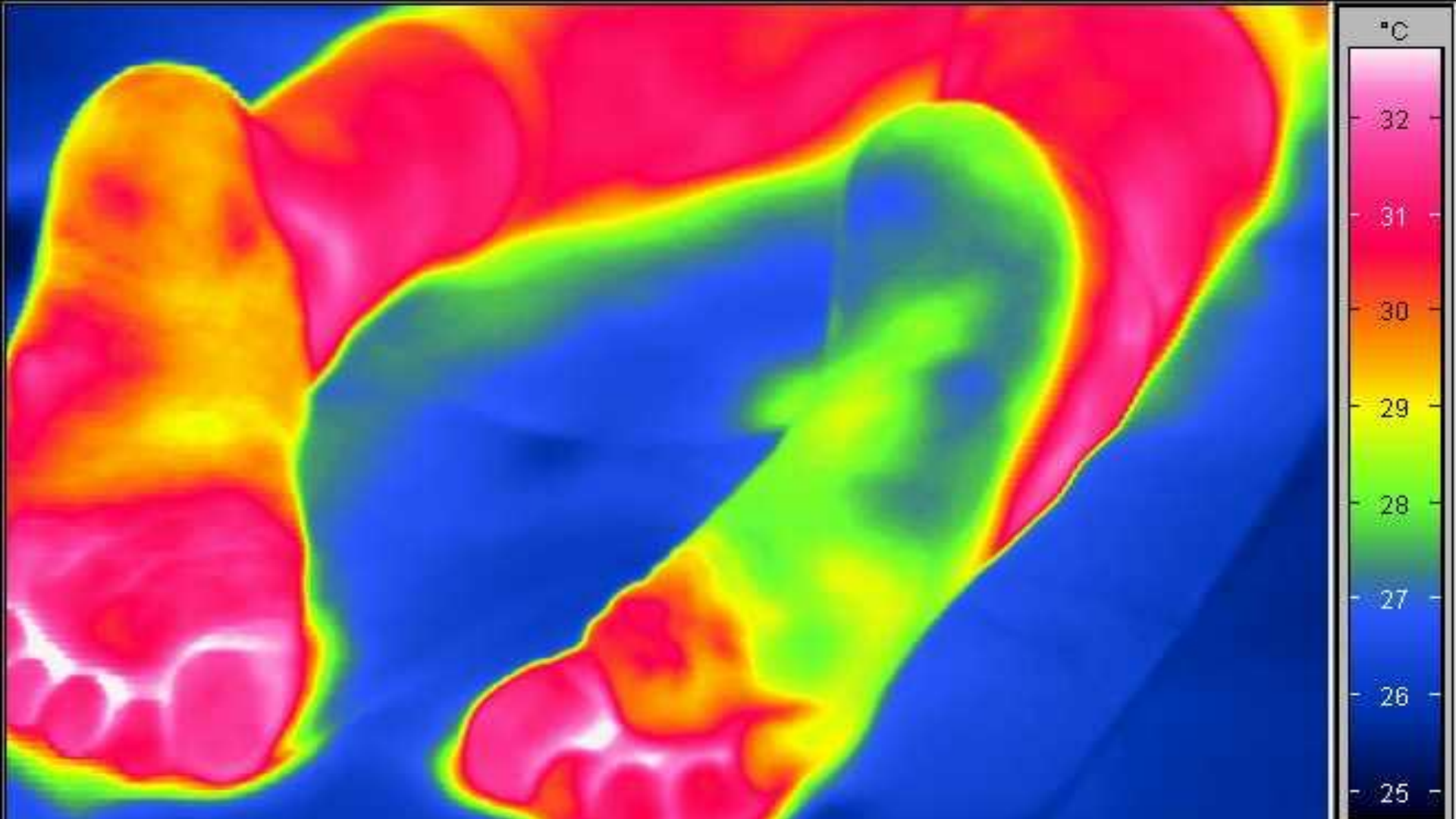
REVERSED FOOTGRAMS TO FACILITATE COMPARISON.

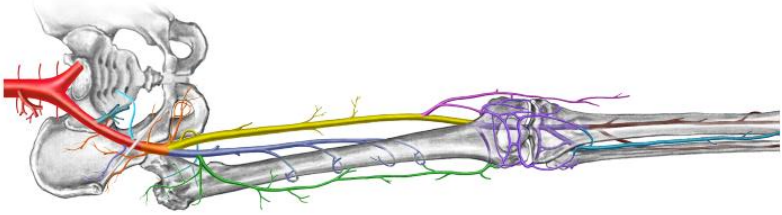
TABLE 1

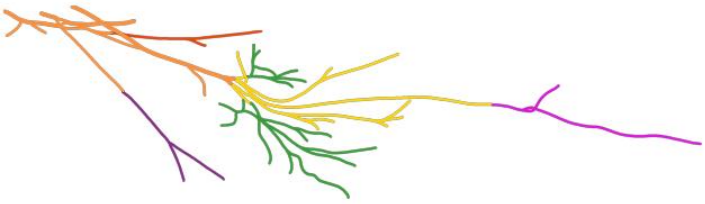
Drugs for pain control in small fiber neuropathy

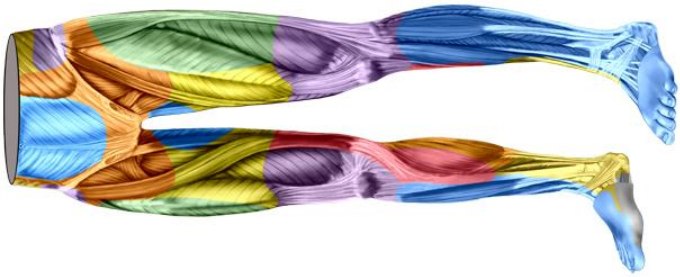
DRUG	DOSAGE (PER DAY)	COMMON SIDE EFFECTS
Antidepressants		
Amitriptyline (Elavil)	20–150 mg	Sedation, weight gain, anticholinergic effects, sexual dysfunction, arrhythmia (side effects most prominent with amitriptyline)
Nortriptyline (Aventyl)	20–150 mg	
Desipramine (Norpramin)	20–200 mg	
Duloxetine (Cymbalta)	60–120 mg	
Anticonvulsants		
Gabapentin (Neurontin)	600–3,600 mg	Sedation, dizziness, peripheral edema, weight gain
Pregabalin (Lyrica)	150–600 mg	Similar to gabapentin
Topiramate (Topamax)	25–400 mg	Weight loss, sedation, cognitive slowing, renal stones, paresthesias
Lamotrigine (Lamictal)	25–400 mg	Stevens-Johnson syndrome, rash, dizziness, nausea, sedation
Carbamazepine (Tegretol)	200–1,200 mg	Dizziness, sedation, ataxia, aplastic anemia, liver enzyme elevation
Oxcarbazepine (Trileptal)	600–2,400 mg	Dizziness, nausea, fatigue, leukopenia
Topical anesthetics		
5% Lidocaine patch (Lidoderm)	Every 12 hours	Local edema, burning, erythema
0.075% Capsaicin patch	Three or four times a day	Burning
Opioids, opioid agonists		
Tramadol (Ultram)	100–400 mg	Sedation, dizziness, seizures, nausea, constipation
Oxycodone (Oxycontin)	10–100 mg	Sedation, constipation, nausea; potential for addiction and abuse

Next sponsors for thermography researches and meetings

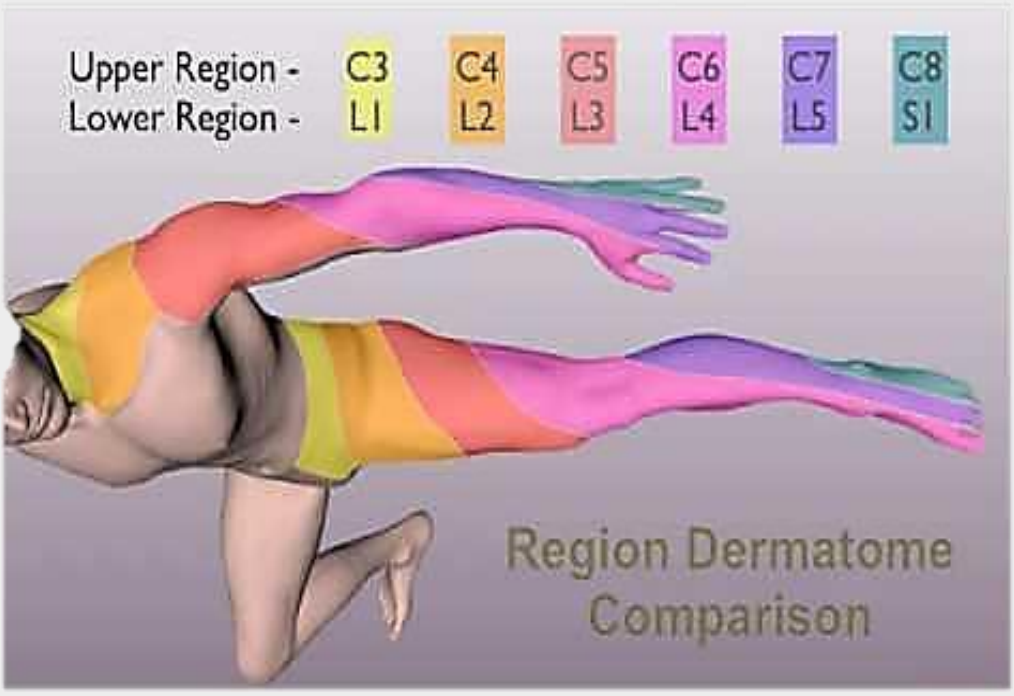

°C
32
31
30
29
28
27
26
25

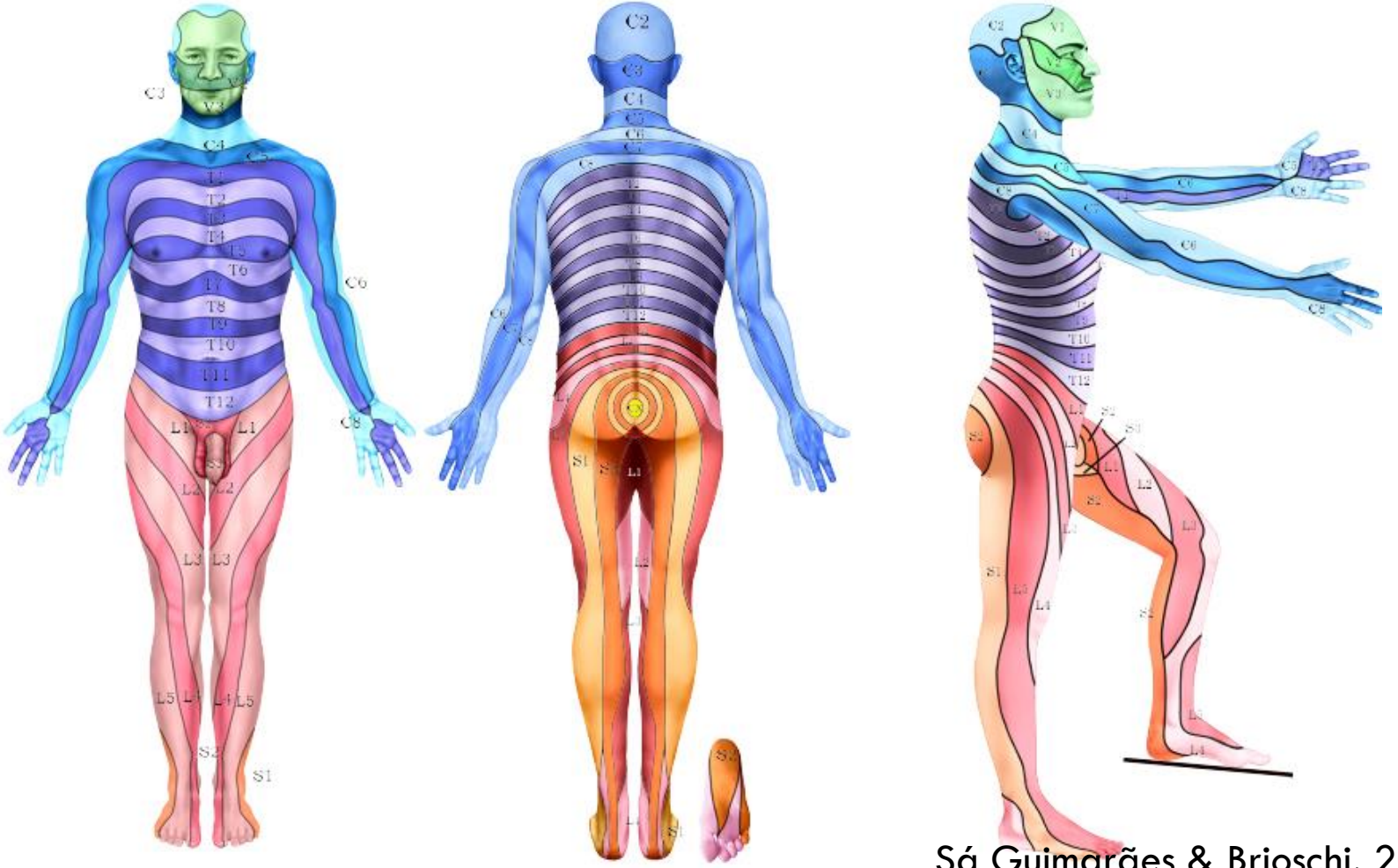




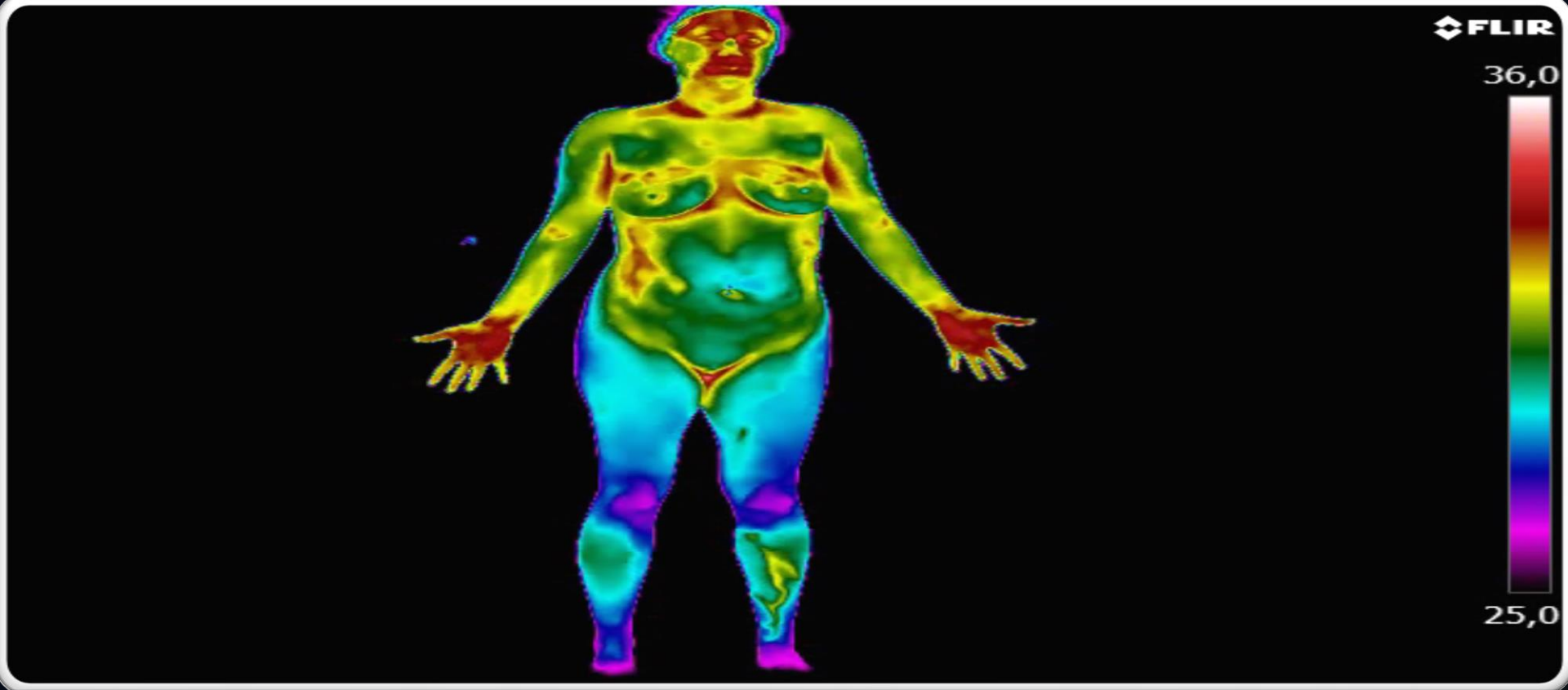


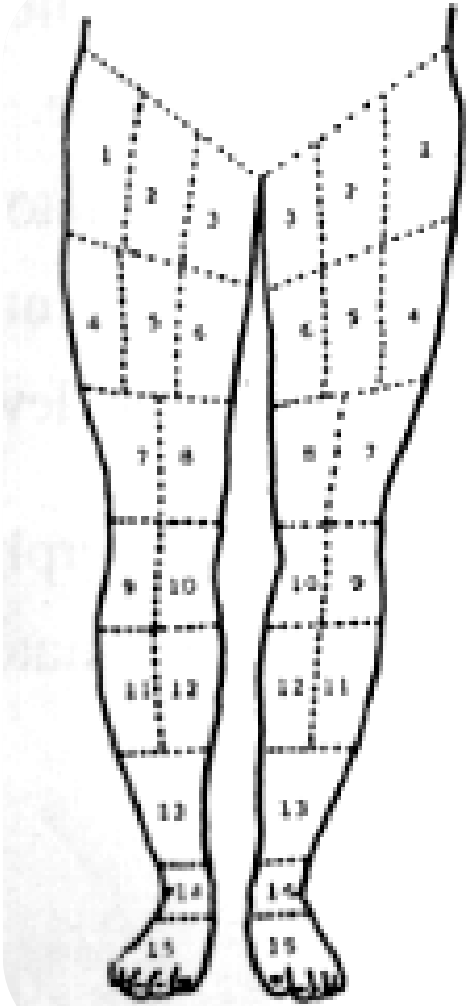
Sá Guimarães & Brioschi, 2017

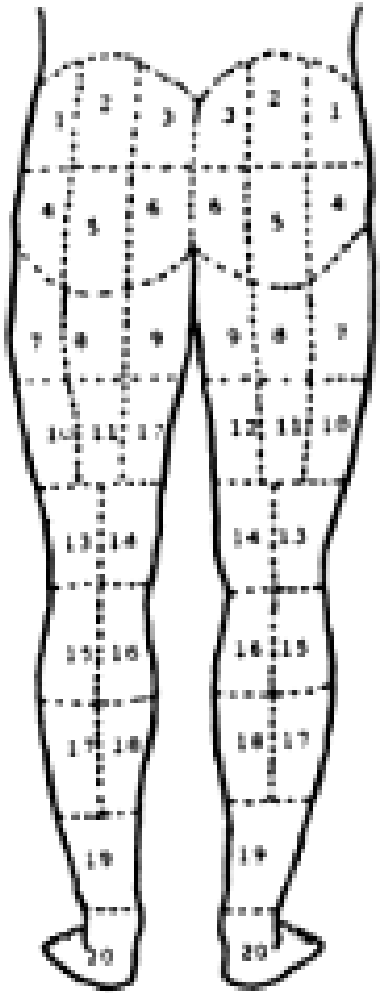


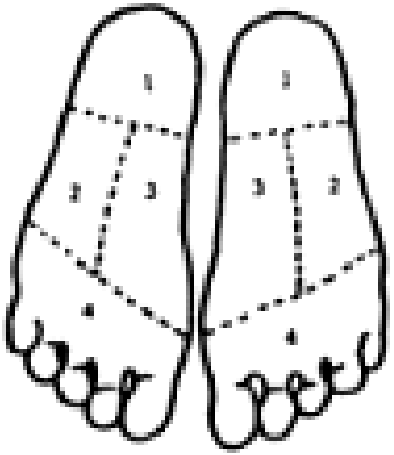


Sá Guimarães & Brioschi, 2017

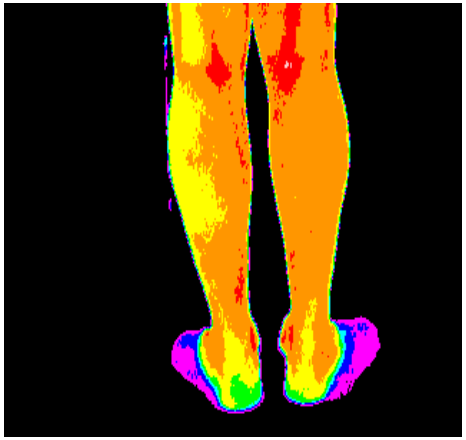

FLIR
36,0
25,0

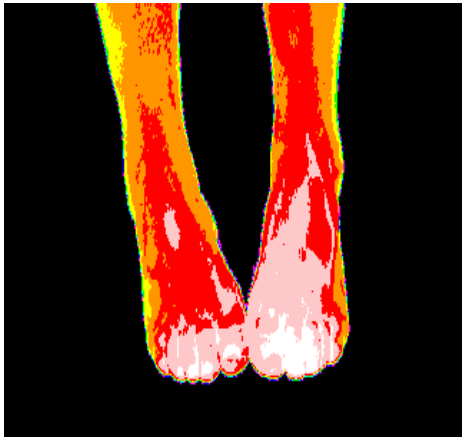


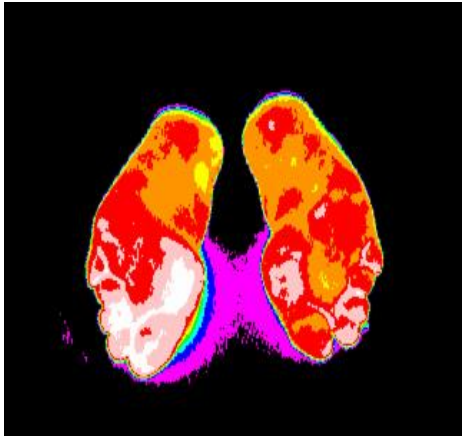




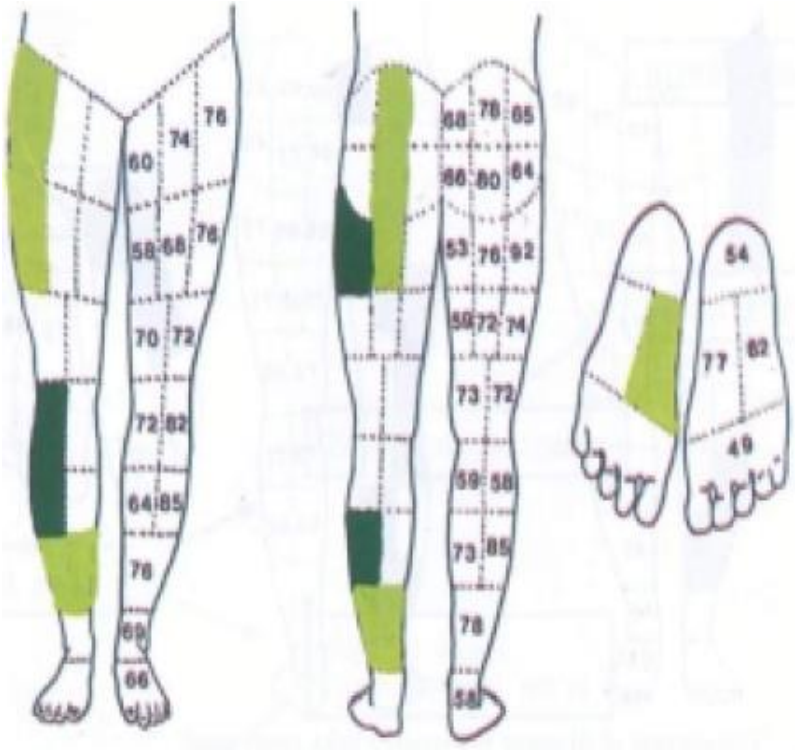
Kim YS et al. *J Korean Med Therm*, 2001





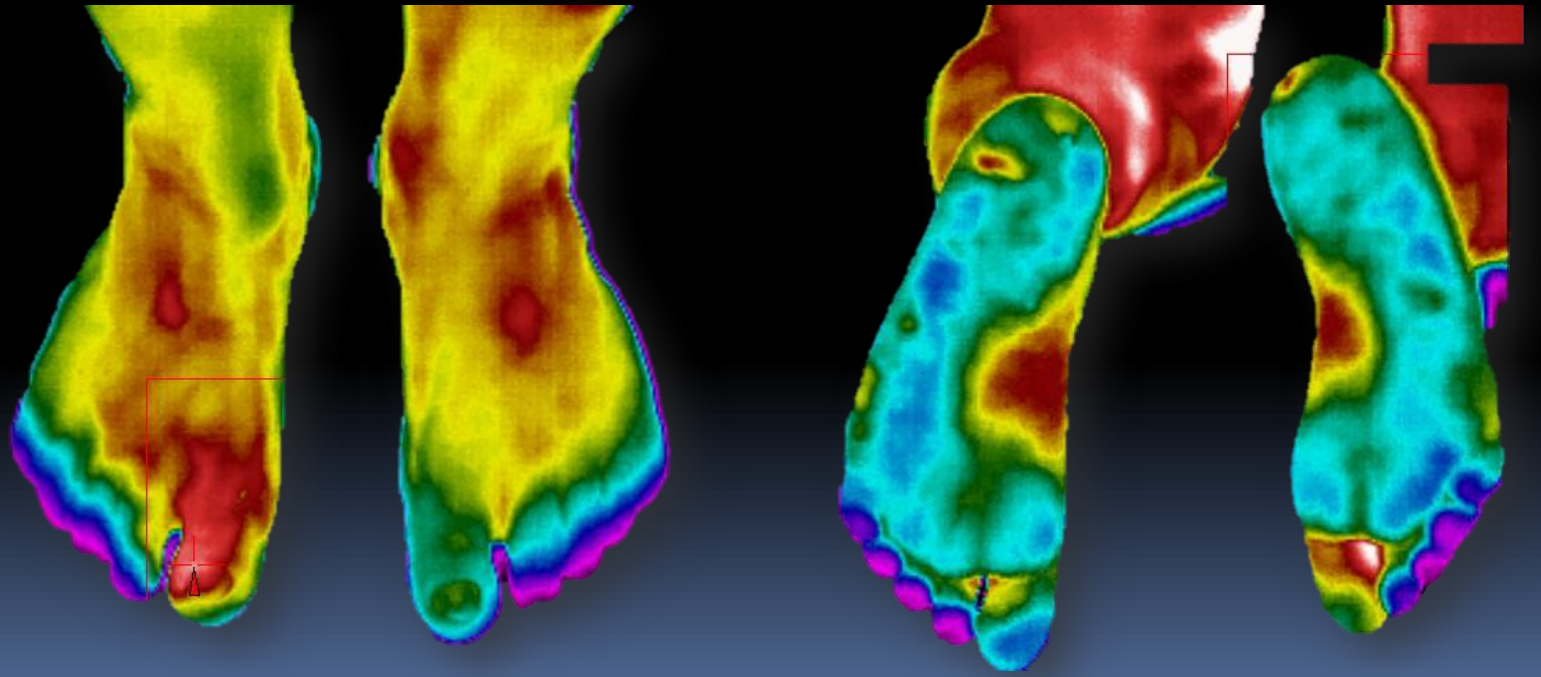


L5 thermatome

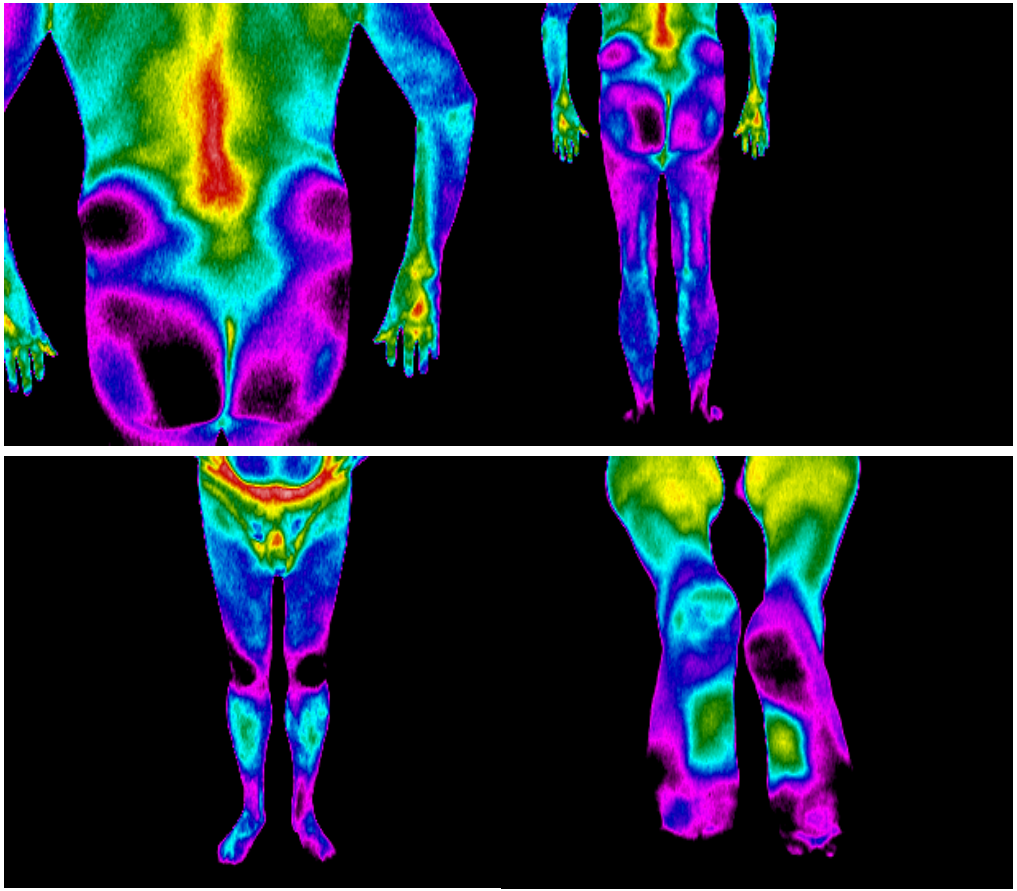


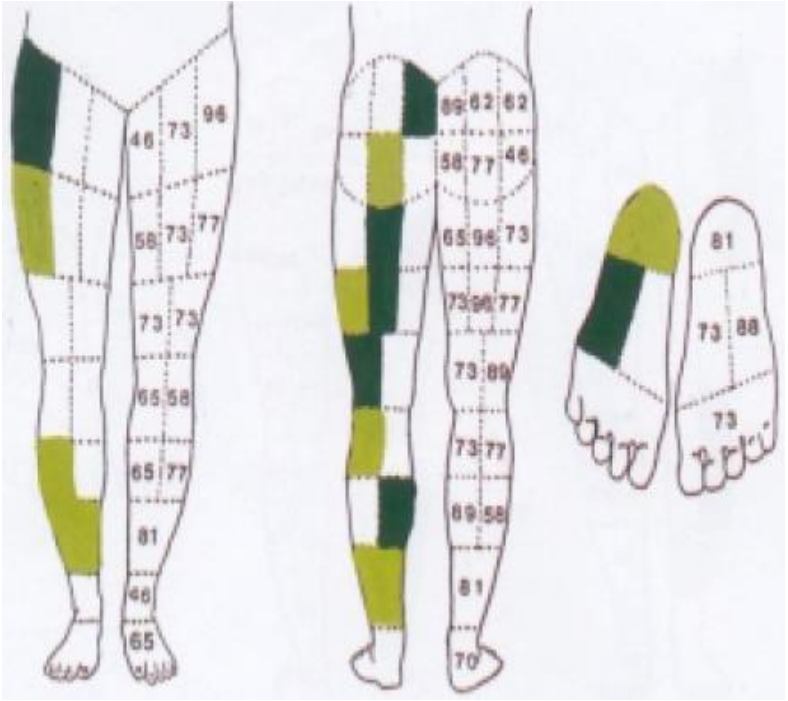
Kim YS e Cho YE, 1995 (n=1458)

L5 radicular



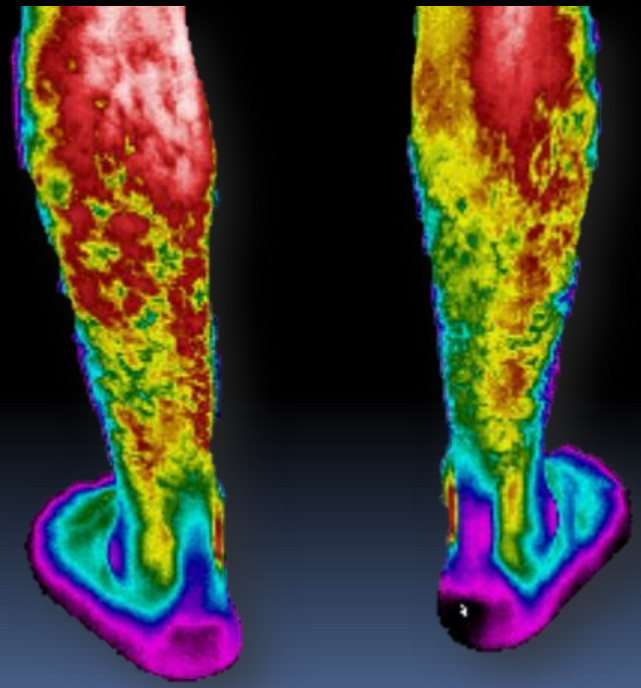
S1 thermatome

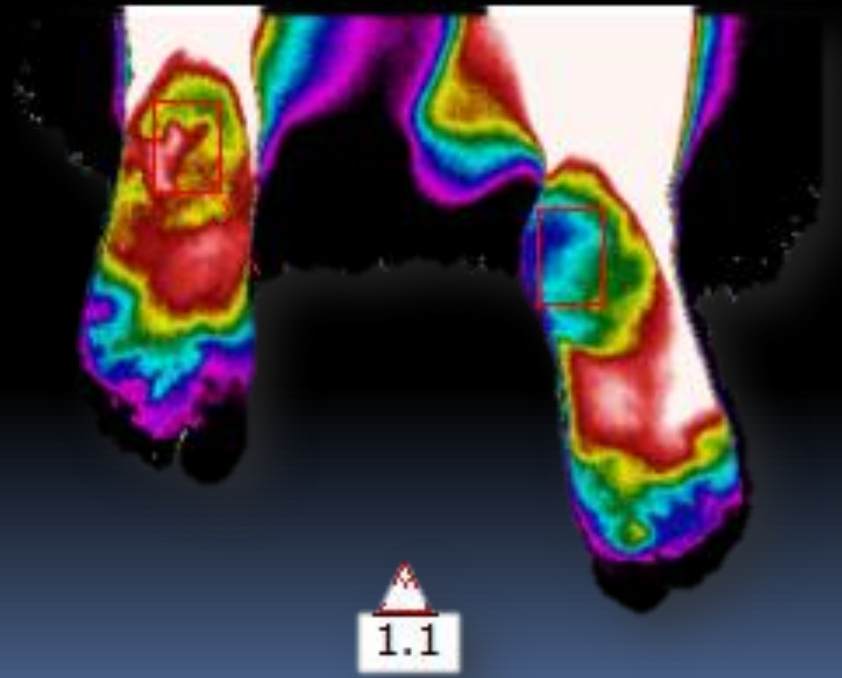




Kim YS e Cho YE, 1995 (n=1458)

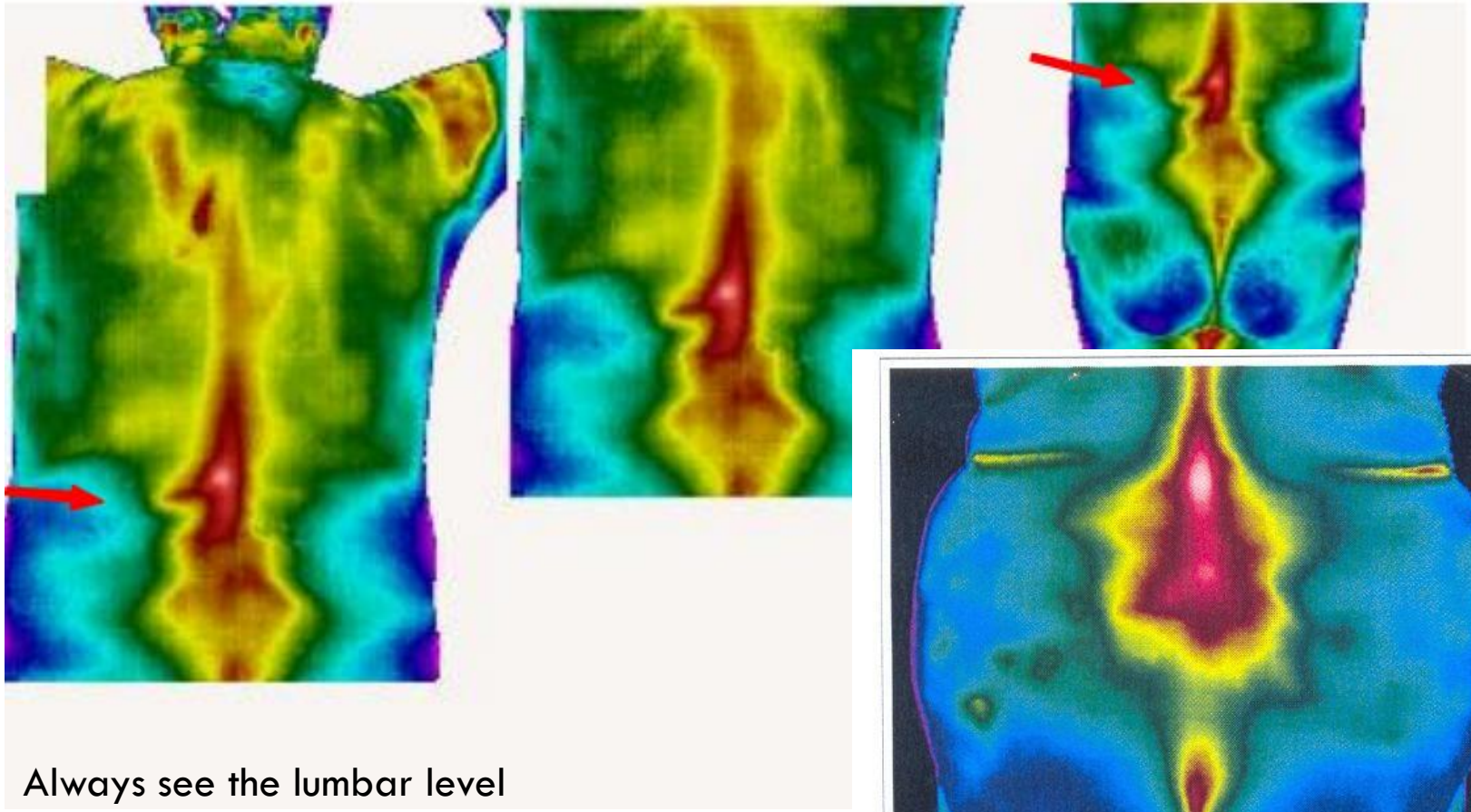
S1 radicular

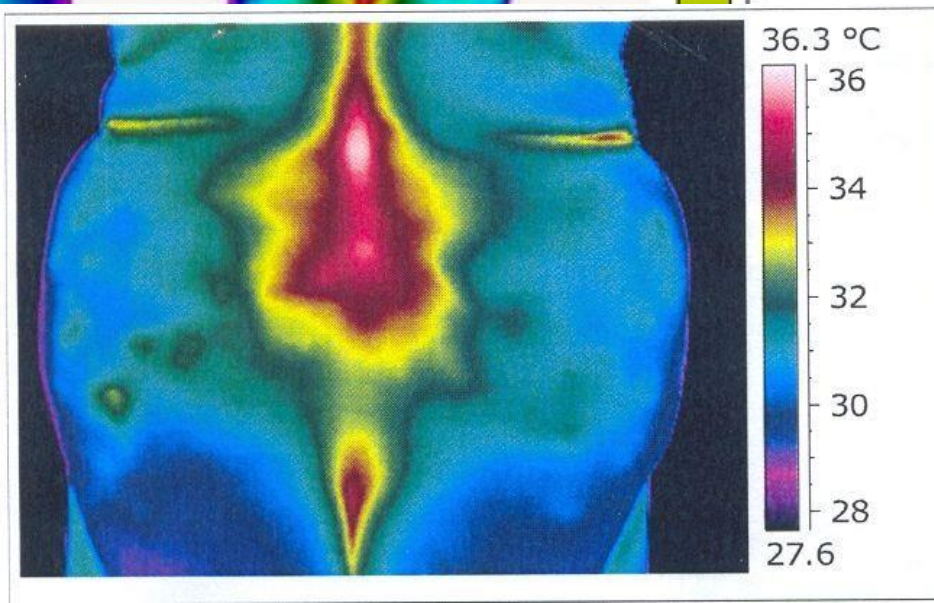




Always see the lumbar level

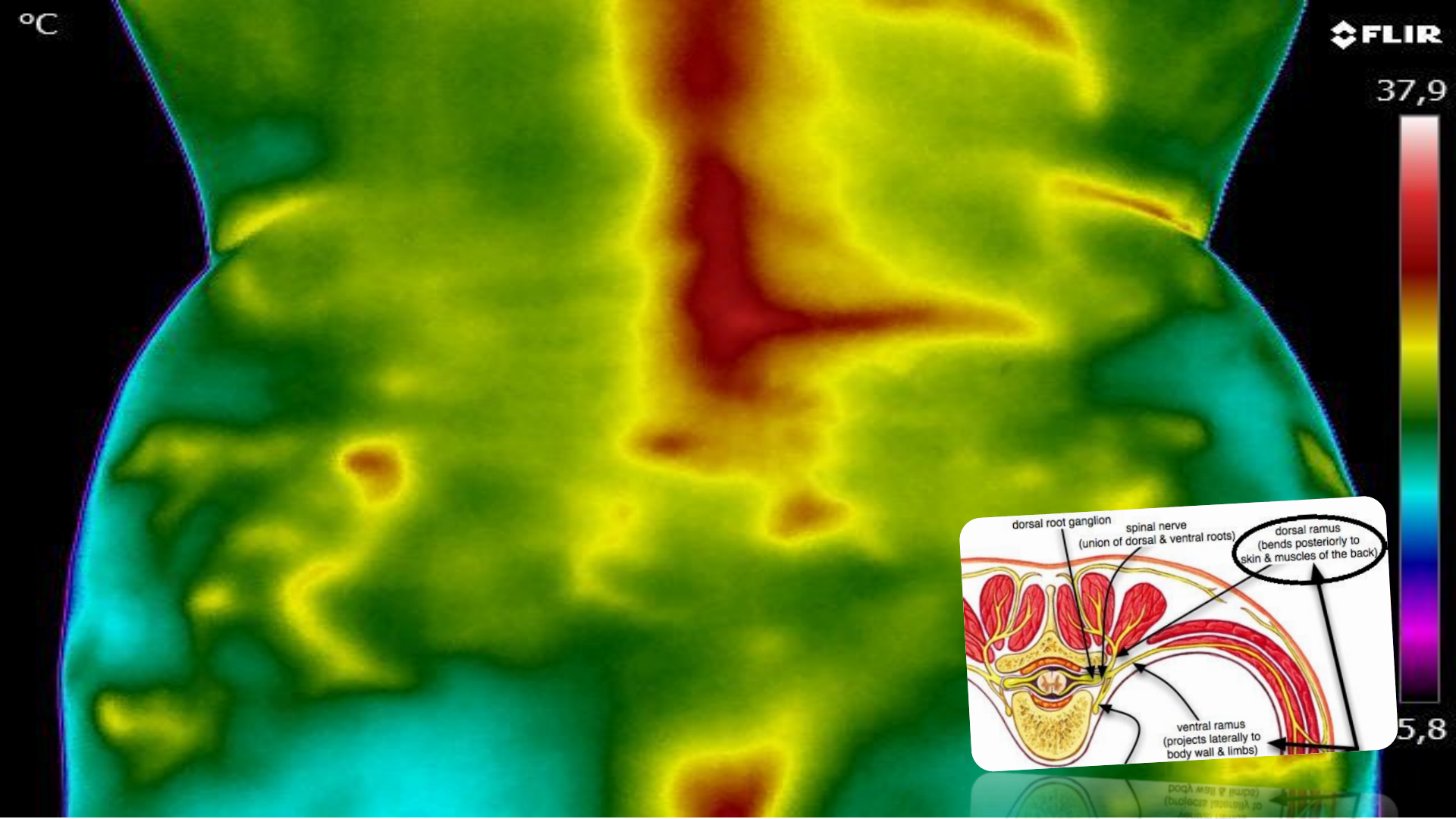
The “flame” sign





Always see the lumbar level

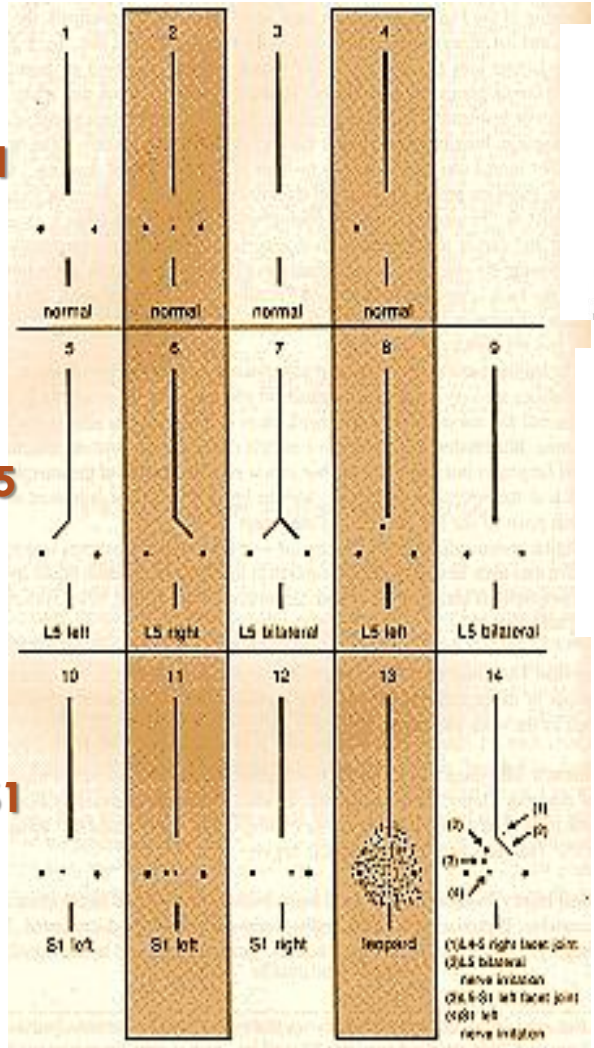
“Flame” sign

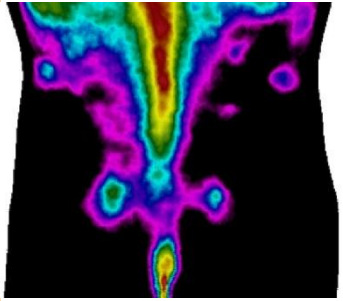

°C
FLIR
37,9
5,8
dorsal root ganglion
spinal nerve
(union of dorsal & ventral roots)
dorsal ramus
(bends posteriorly to
skin & muscles of the back)
ventral ramus
(projects laterally to
body wall & limbs)

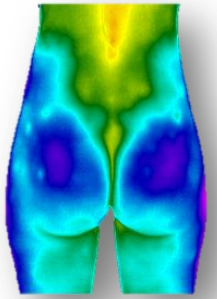
N

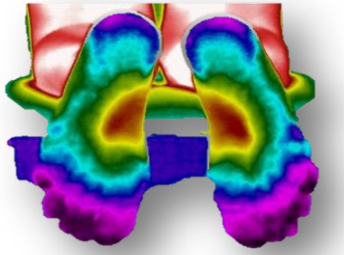
L5

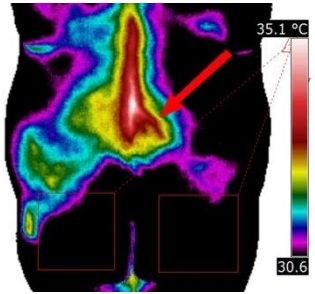
S1

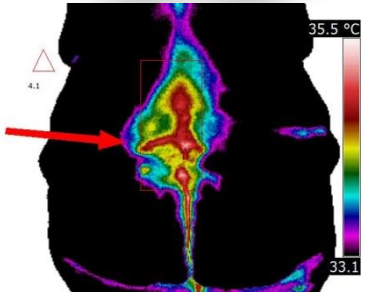

1
2
3
4
normal
normal
normal
normal
5
6
7
8
9
L5 left
L5 right
L5 bilateral
L5 left
L5 bilateral
10
11
12
13
14
S1 left
S1 left
S1 right
Isolated

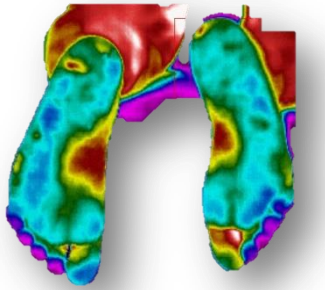


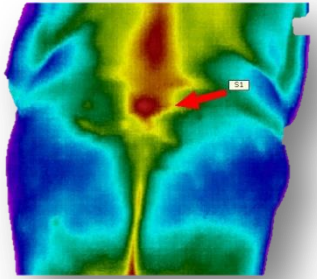


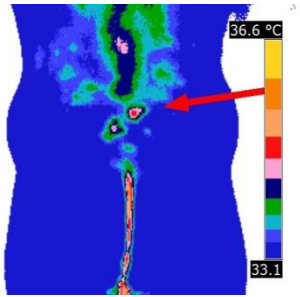


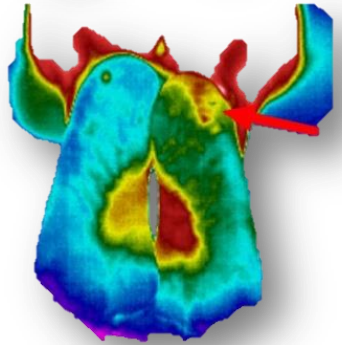

35.1 °C
30.6


35.5 °C
33.1

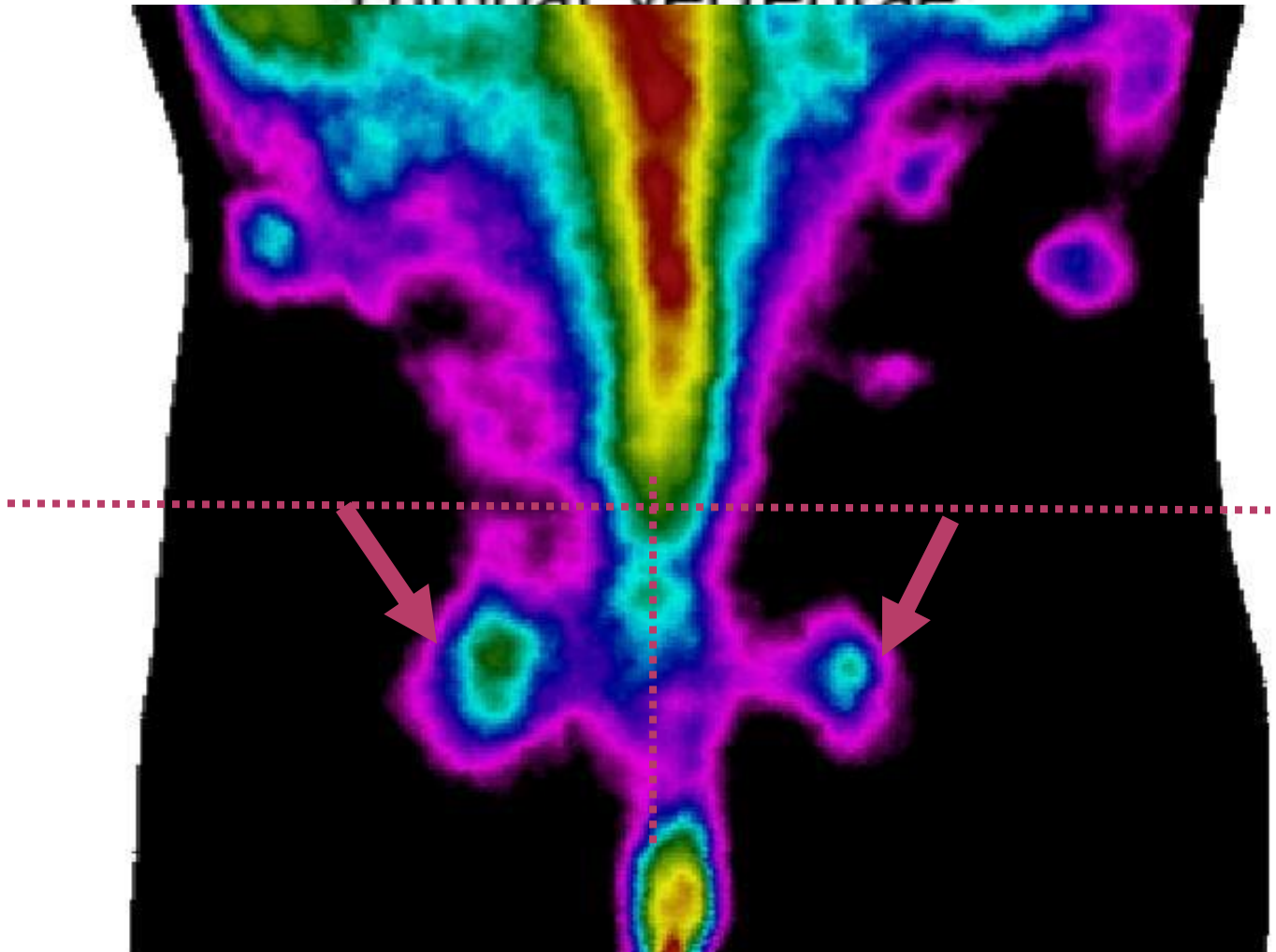


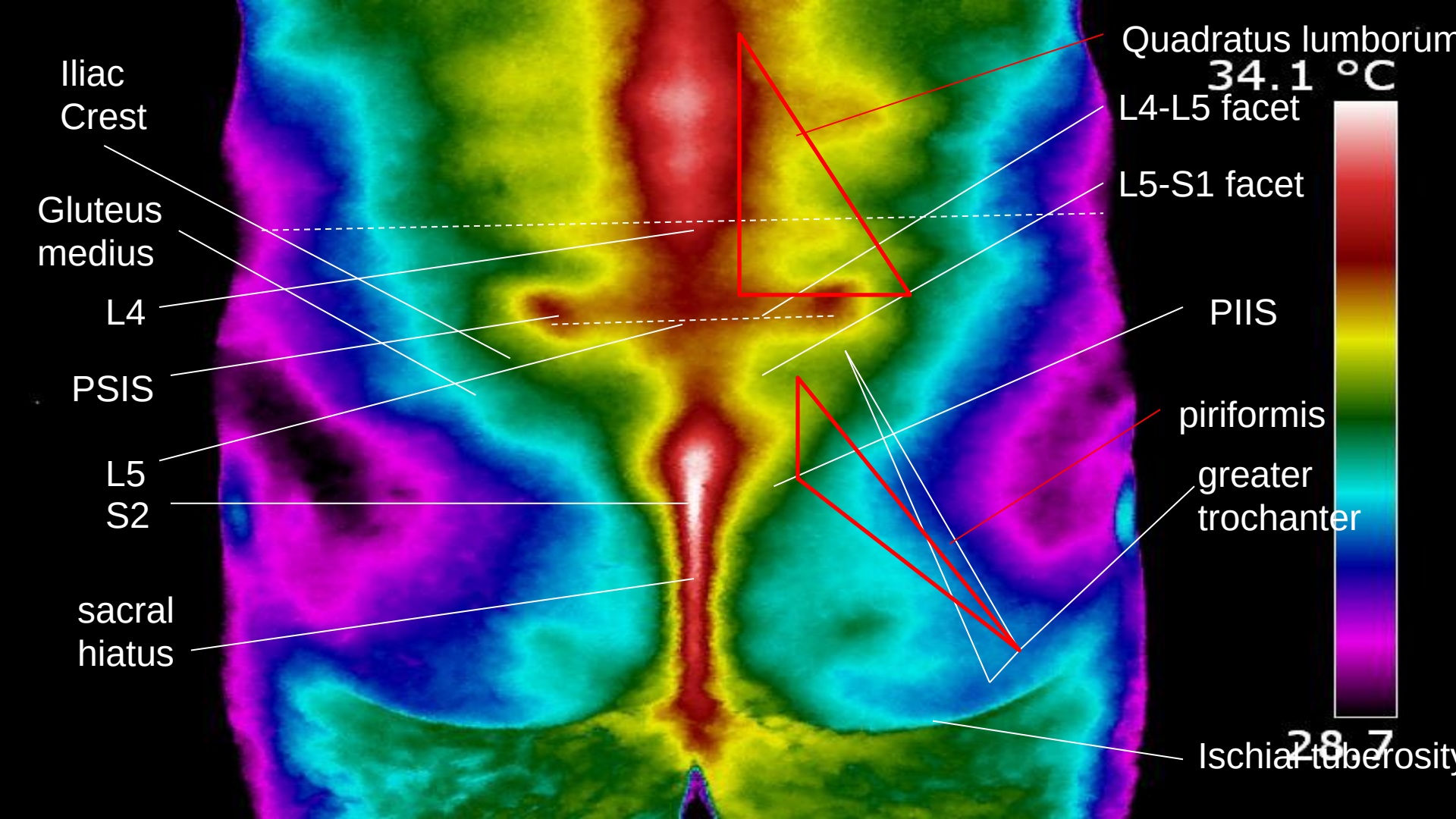


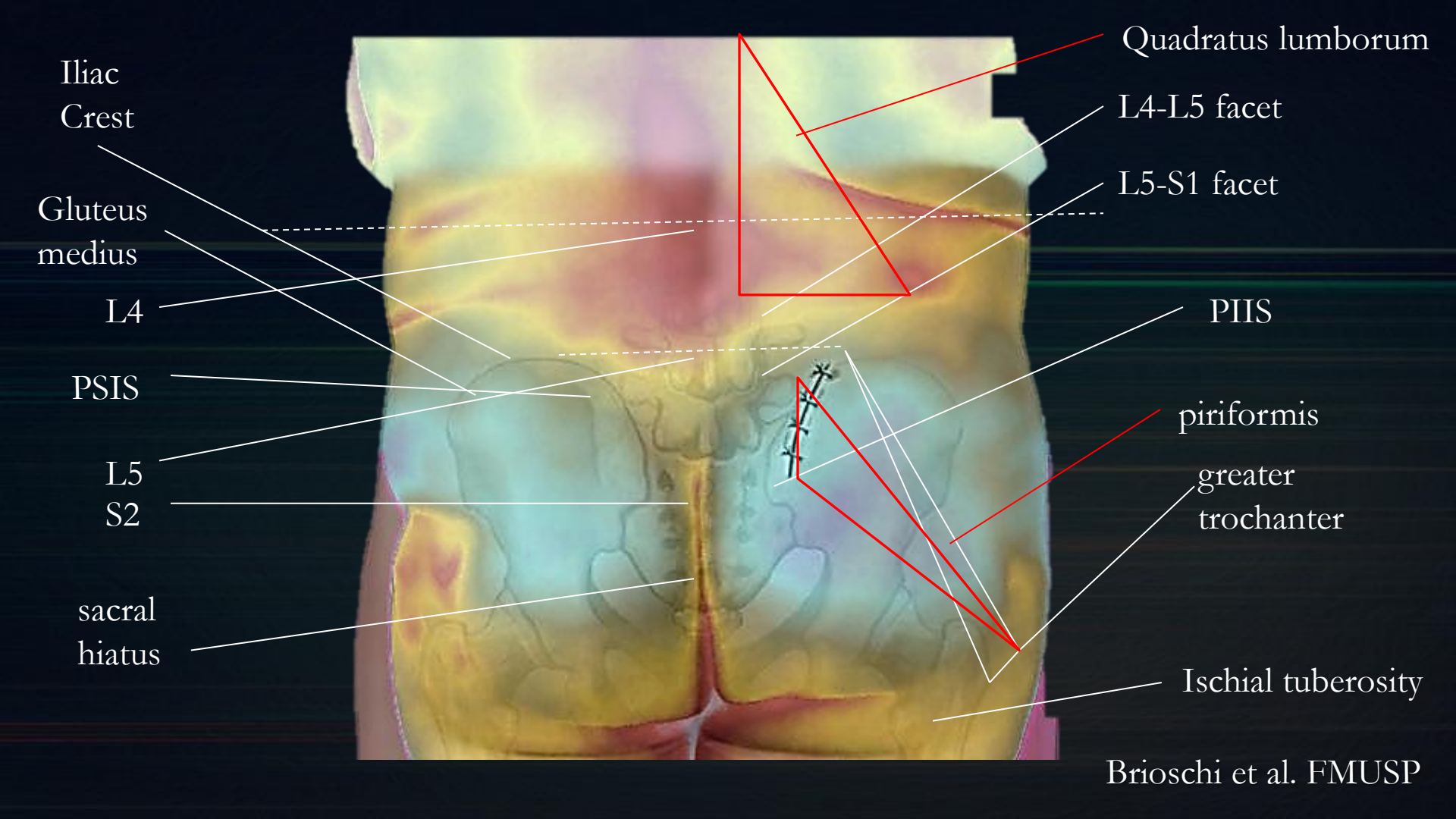

36.6 °C
33.1



Lumbar vertebrae




Iliac Crest
Gluteus medius
L4
PSIS
L5
S2
sacral hiatus
Quadratus lumborum
L4-L5 facet
L5-S1 facet
PIIS
piriformis
greater trochanter
Ischial tuberosity
34.1 °C
28.7


Iliac Crest
Gluteus medius
L4
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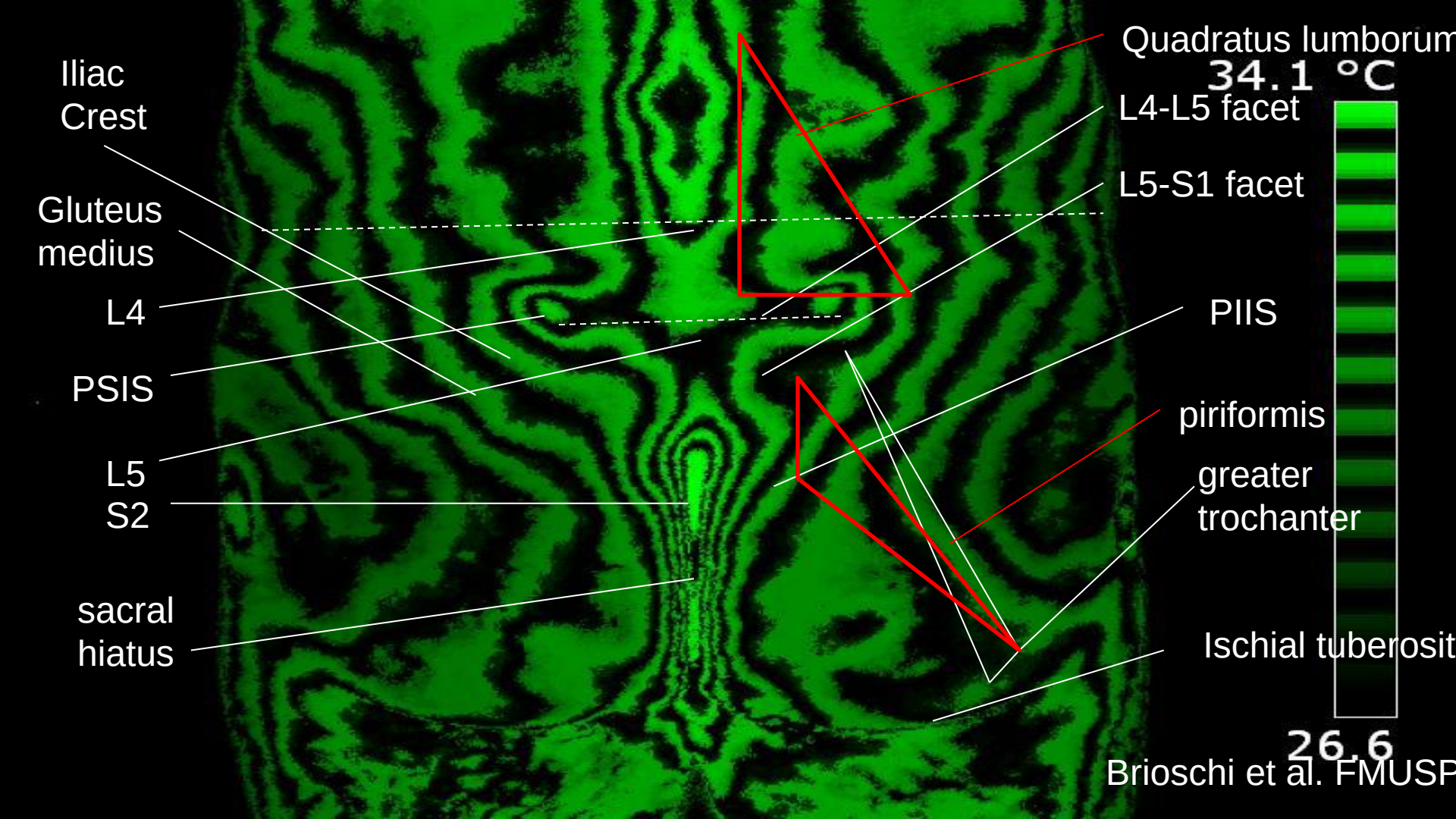
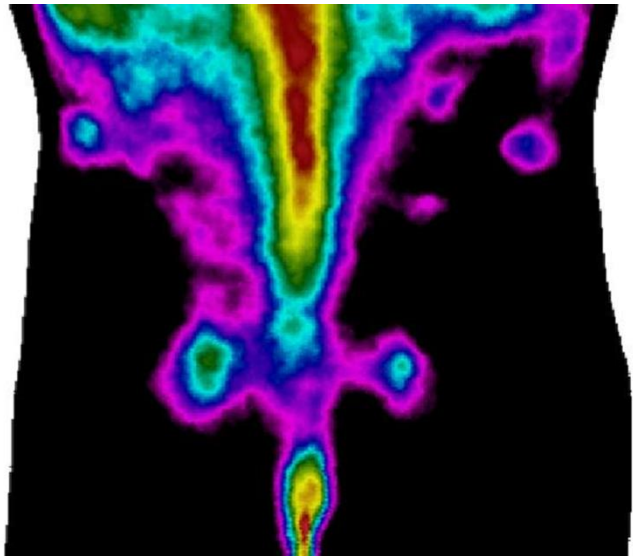
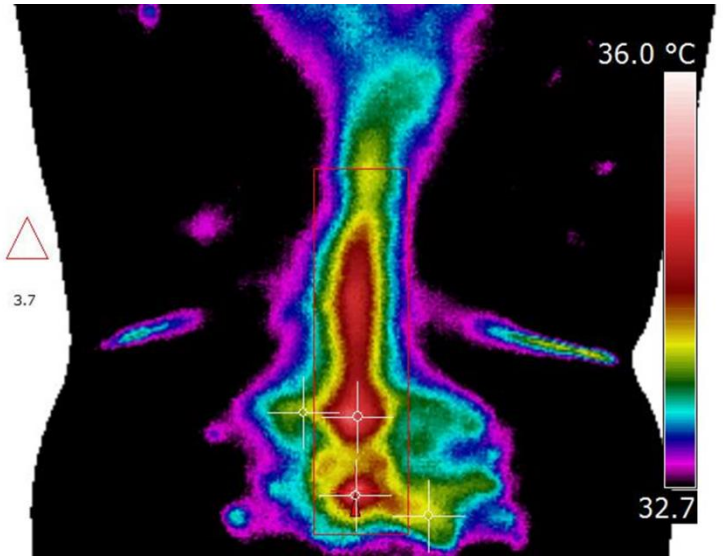
sacral hiatus
Quadratus lumborum
L4-L5 facet
L5-S1 facet
PIIS
piriformis
greater trochanter
Ischial tuberosity
Brioschi et al. FMUSP


Iliac Crest
Gluteus medius
L4
PSIS
L5
S2
sacral hiatus
Quadratus lumborum
L4-L5 facet
L5-S1 facet
PIIS
piriformis
greater trochanter
Ischial tuberosit
34.1 °C
26.6
Brioschi et al. FMUSP

Normal for age

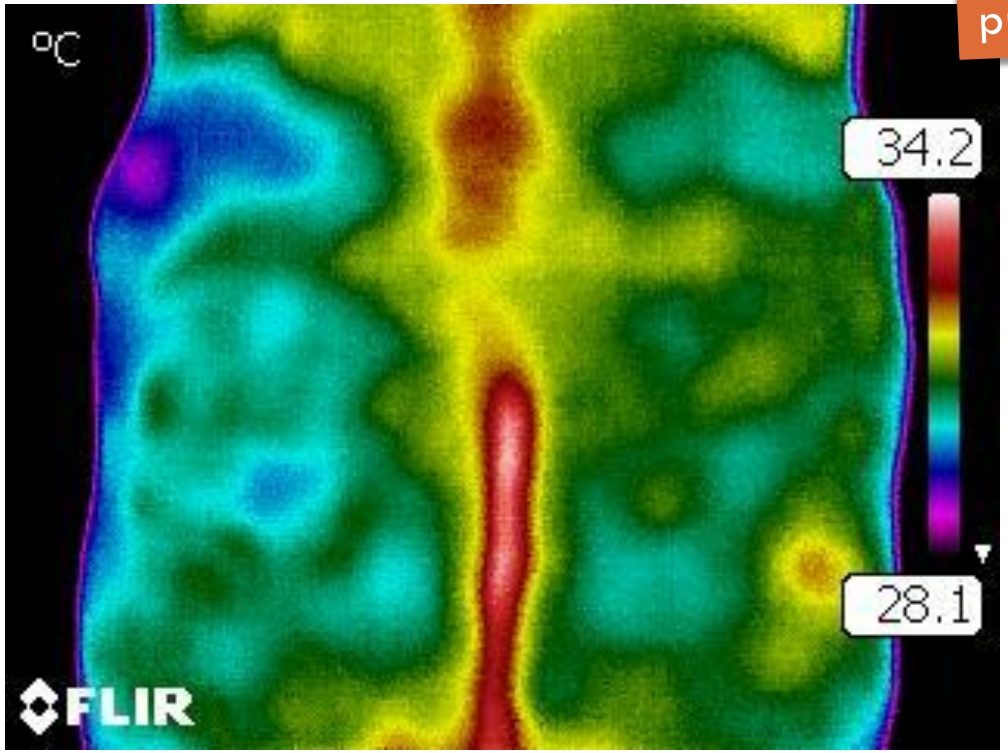


Discopathy + R Facet L5-S1

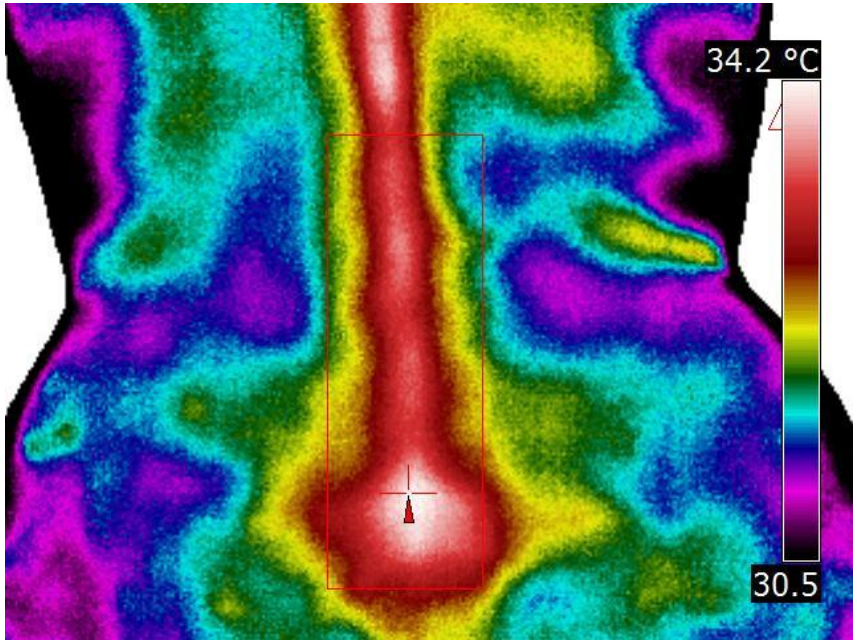


Discopathy

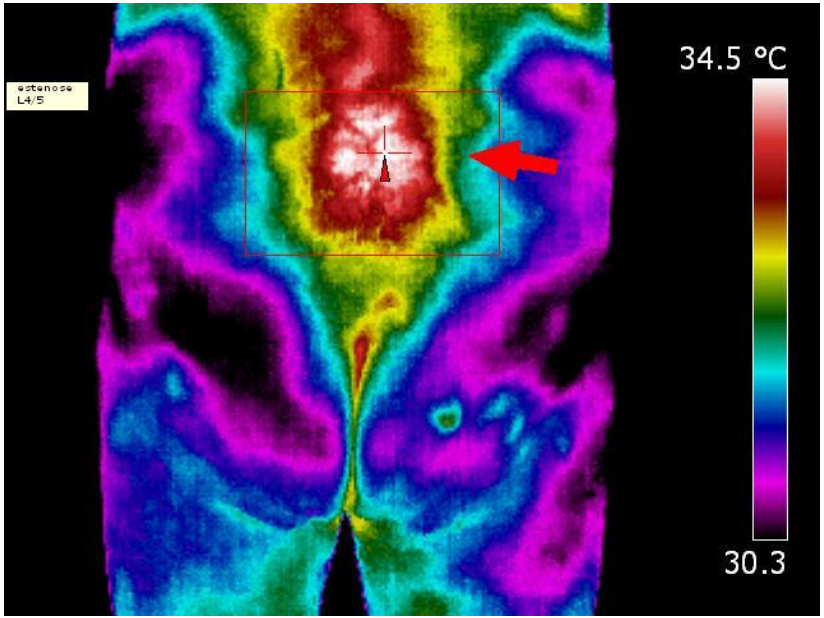
Objective: correct and early indication of minimally invasive procedures

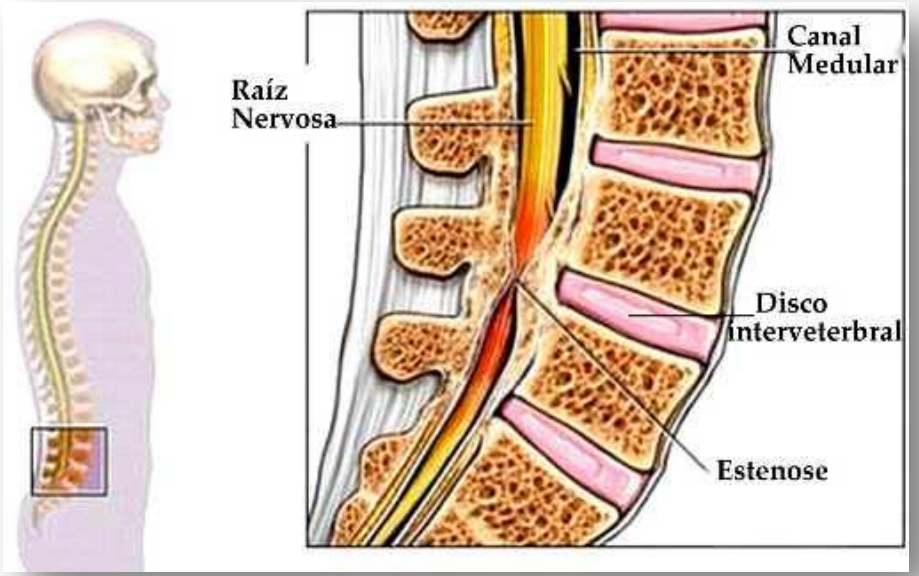


L4-L5 discopathy

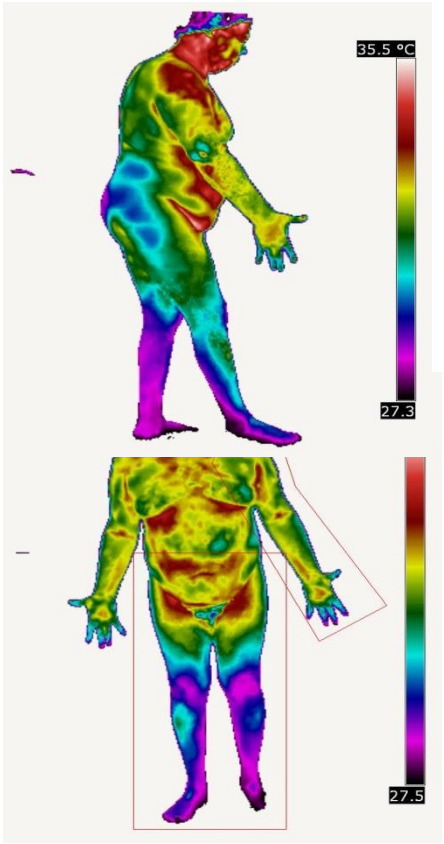


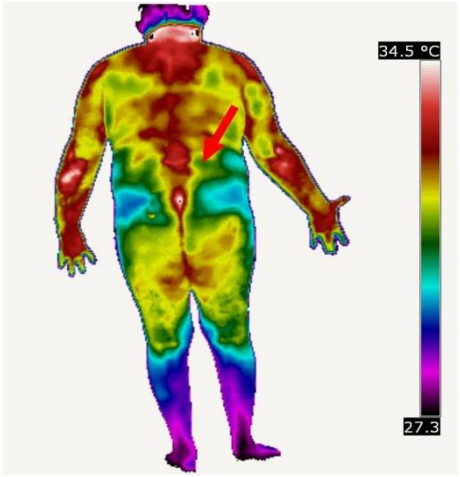
L4-L5 stenosis

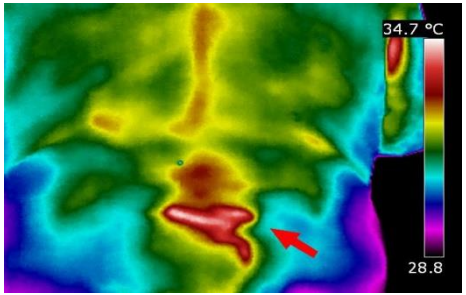


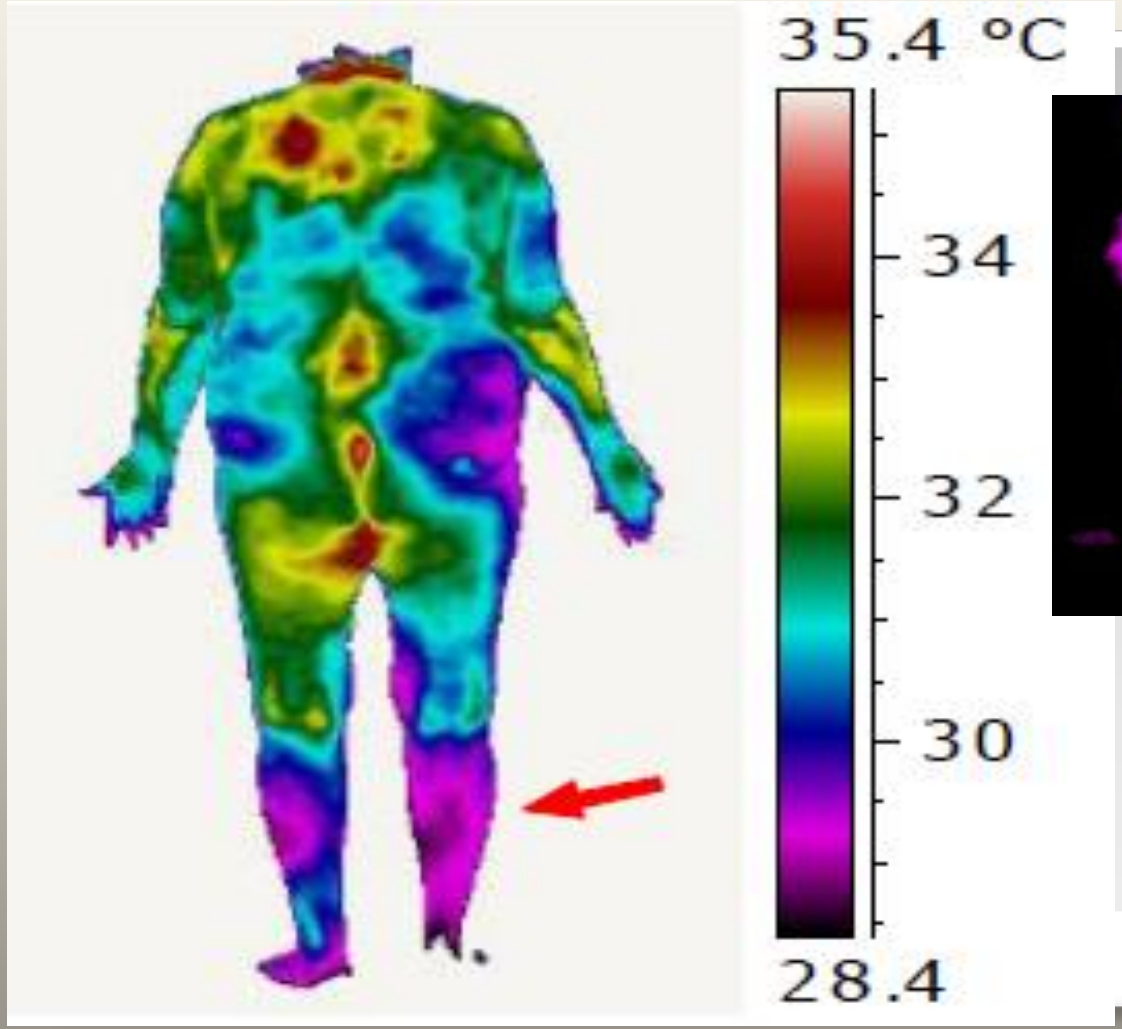


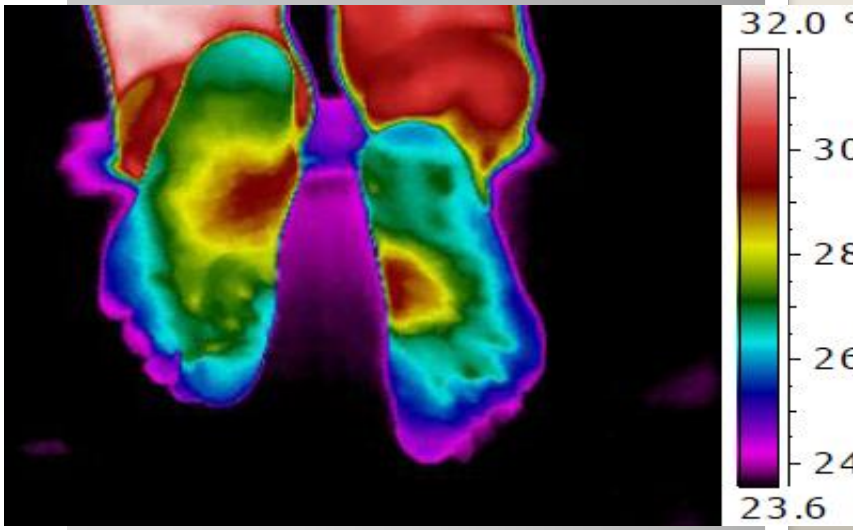
L4-L5 stenosis








35.4 °C
34
32
30
28.4

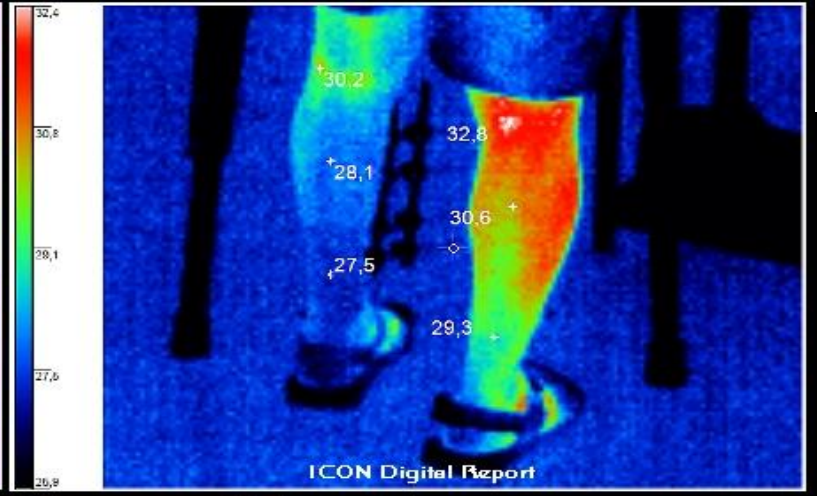

32.0
30
28
26
24
23.6

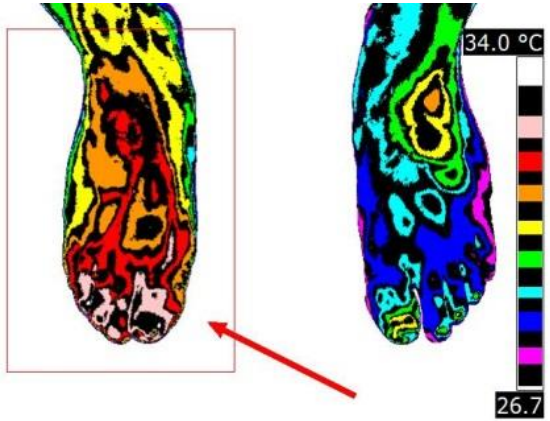
CRPS

COMPLEX REGIONAL PAIN SYNDROME

“The Boot” sign


ICON Digital Report

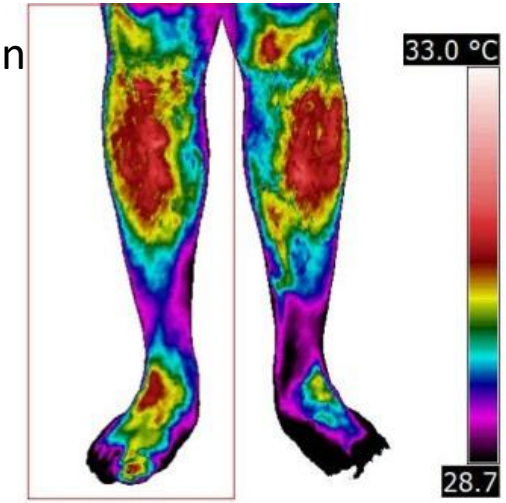

30,2
32,8
28,1
30,6
27,5
29,3
ICON Digital Report

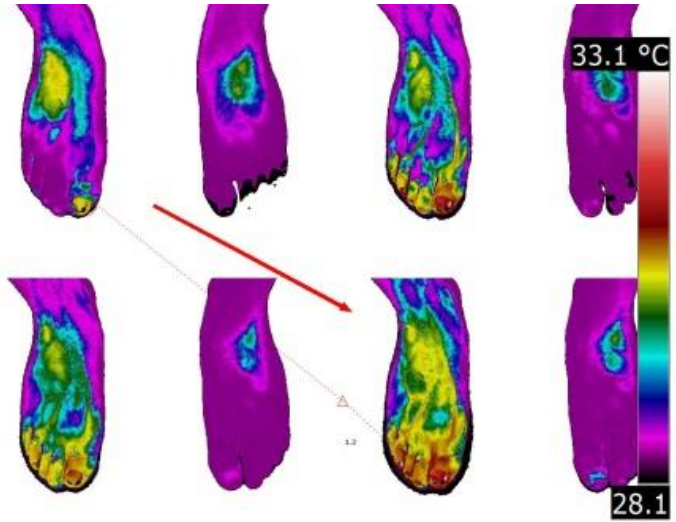


No response to functional cold water autonomic stress testing

Cold Water Stress Test: CRPS

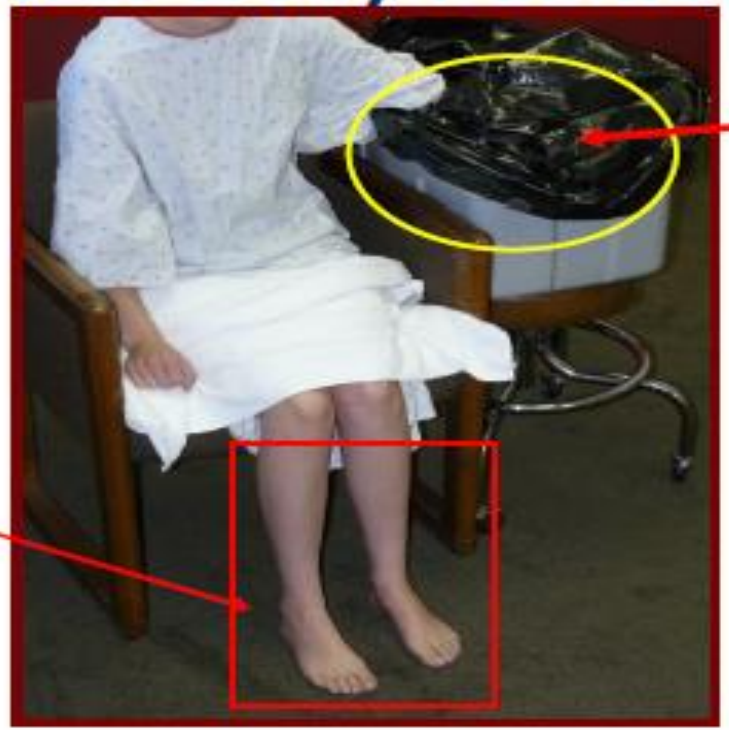
Boot sign





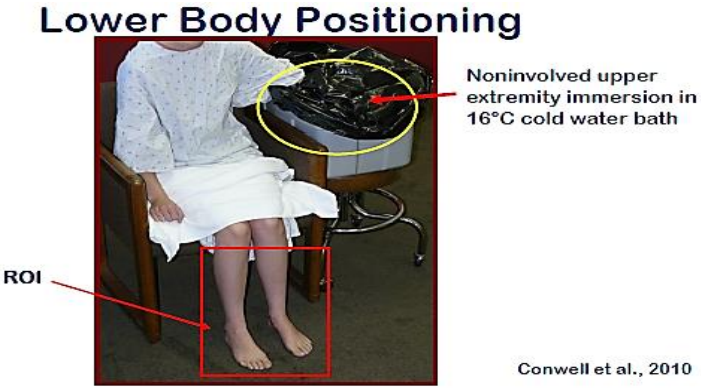
Cold Water Stress Protocol

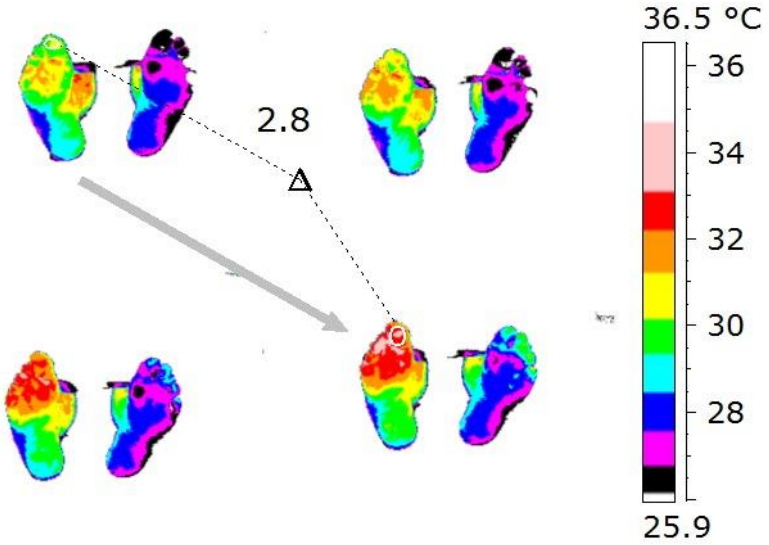
Lower Body Positioning

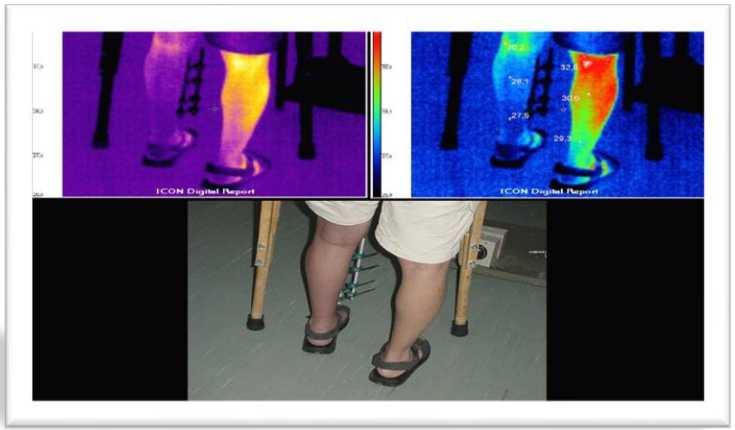


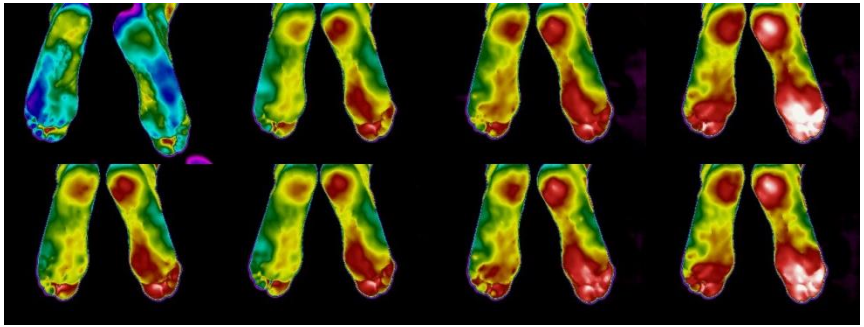
Conwell et al., 2010

Cold Water Stress Test: CRPS









Cold Water Stress Test

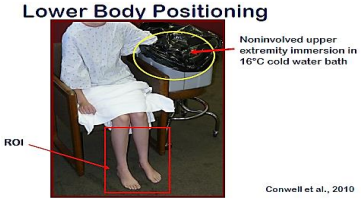
Helps to distinguish:

1. SCDR
2. L5
3. S1
4. Morton neuroma
5. Others

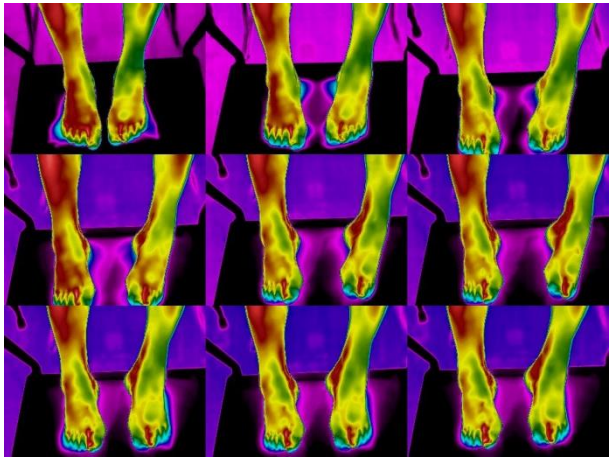
IT IS
MANDATORY
IN THE CASES OF NEUROPATHIC PAIN

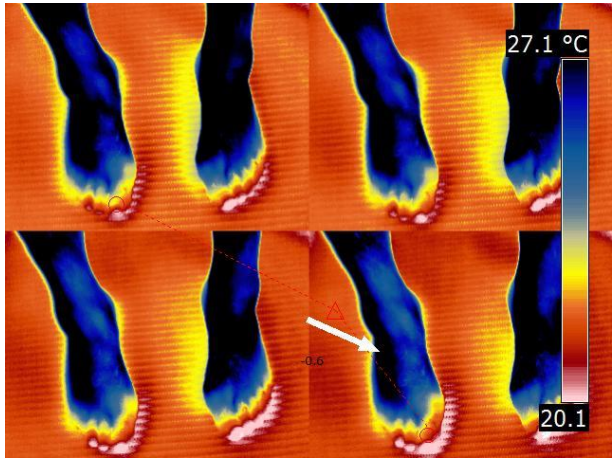
DN4 Questionnaire(Douleur Neuropathique en 4 Questions)

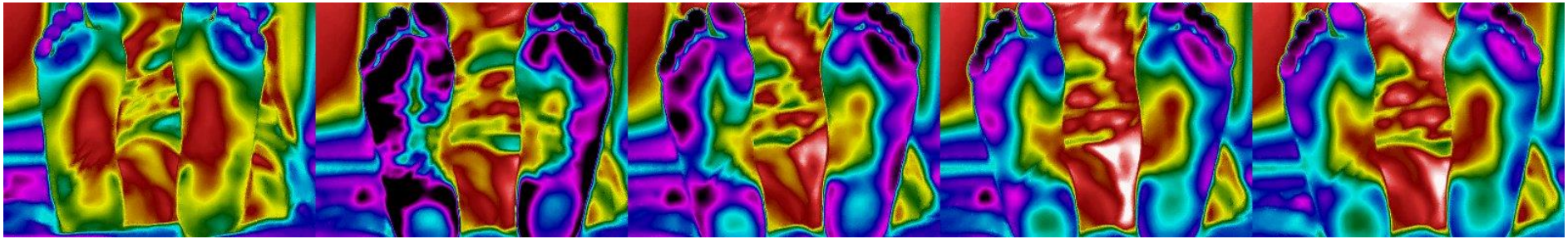
Cold Water Stress Test: L5



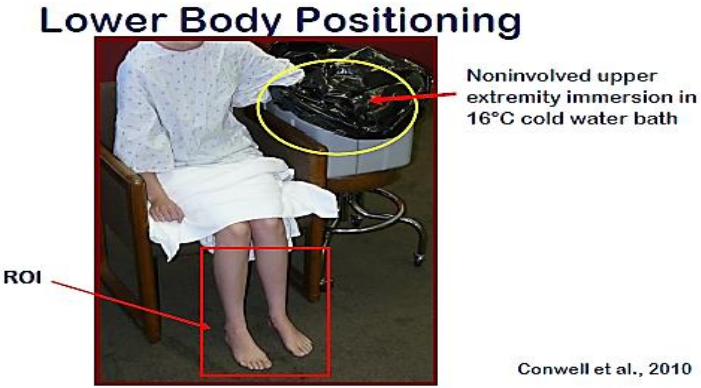
Maintenance of the cutaneous vasoconstrictor reflex

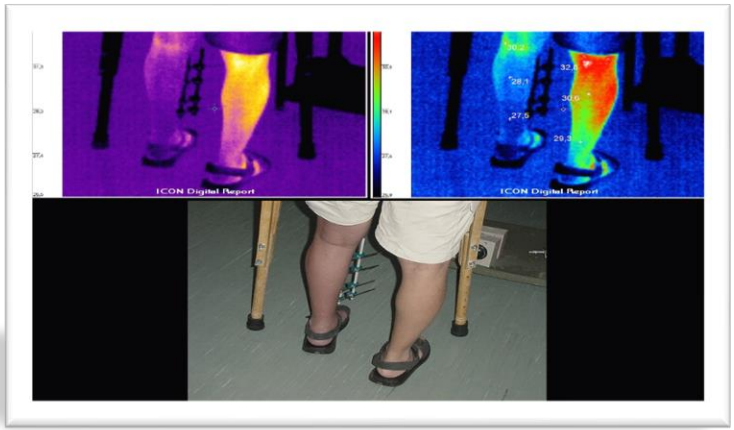


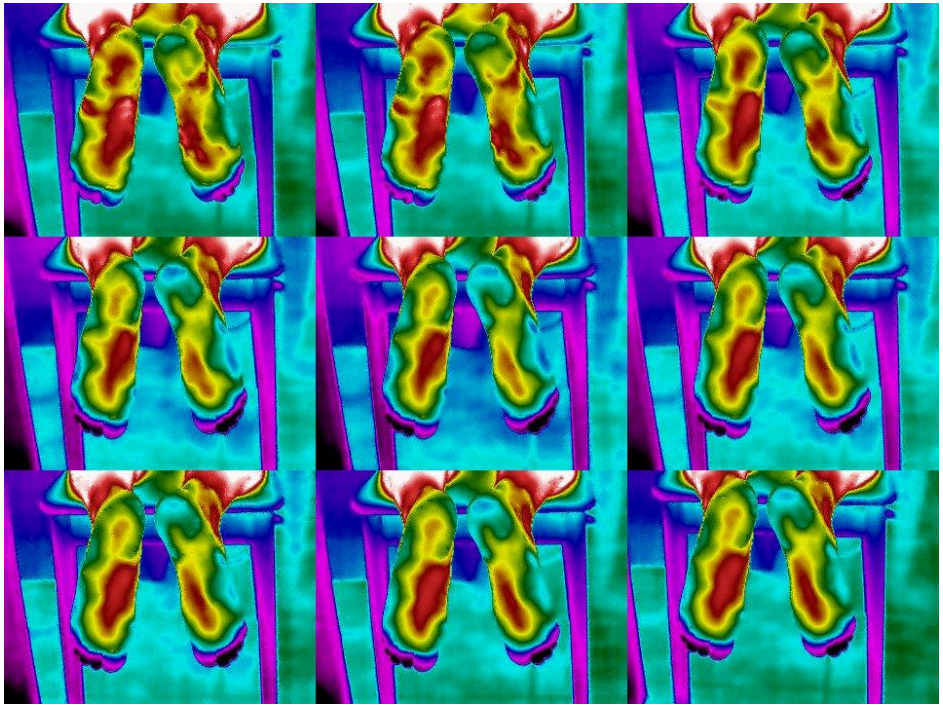




Cold Water Stress Test: S1

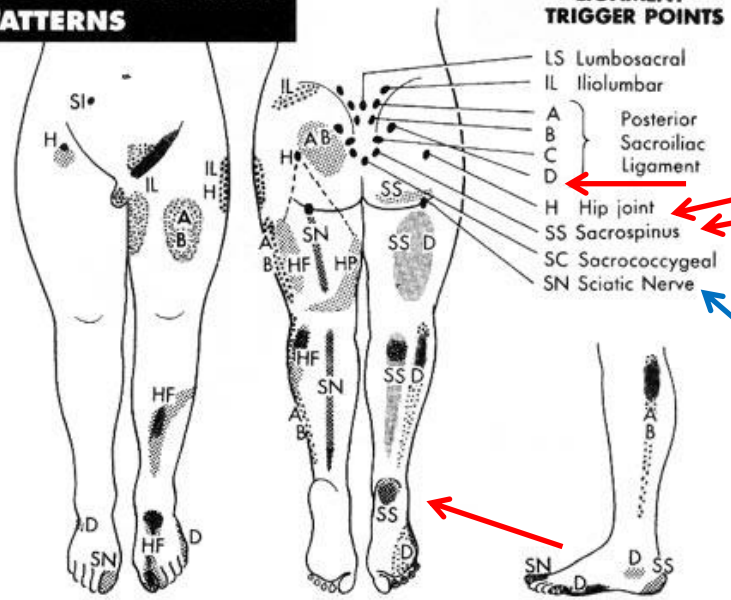


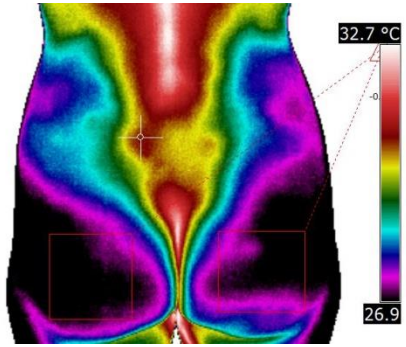


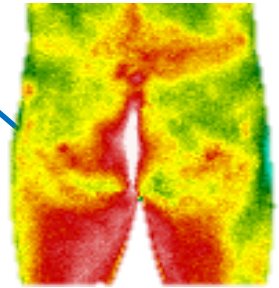


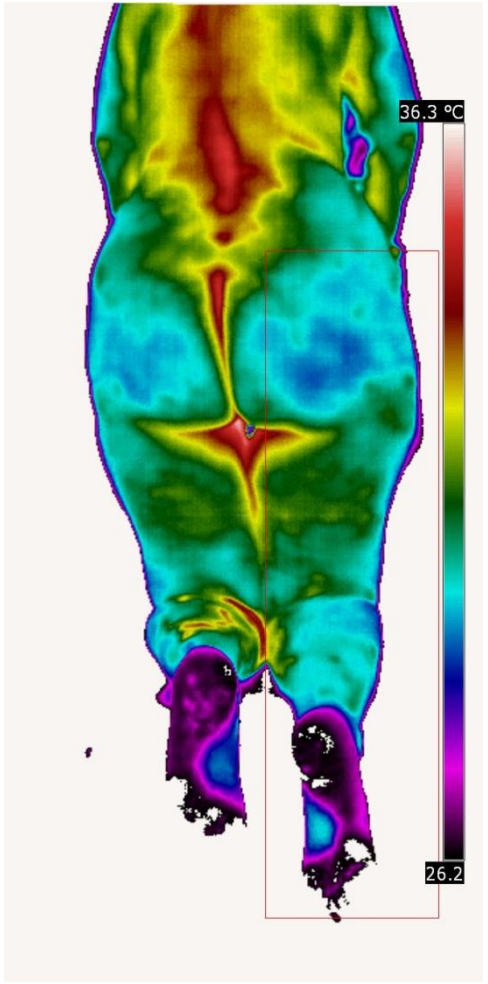
Maintenance of the cutaneous vasoconstrictor reflex

Hackett Referral Patterns







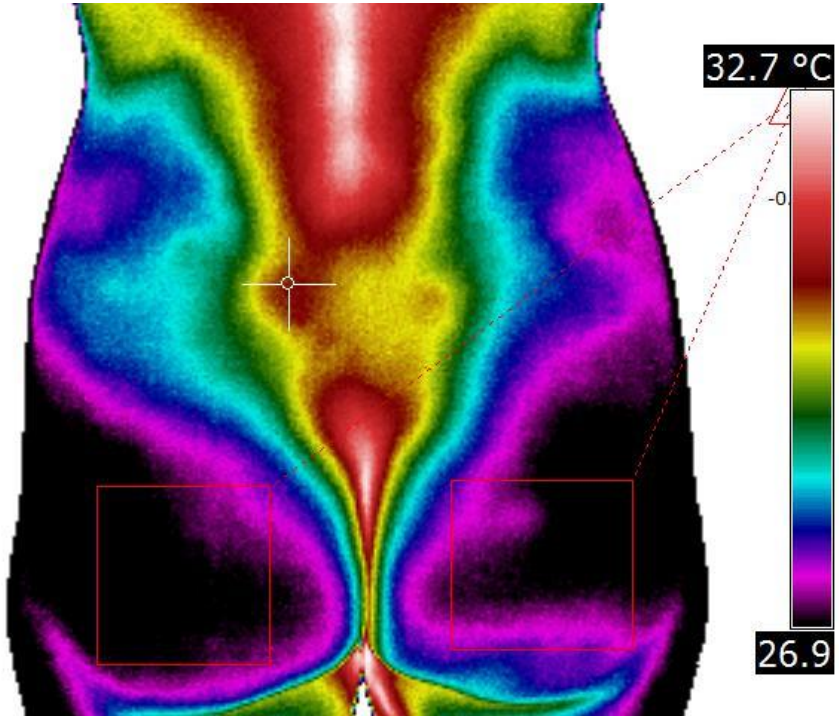


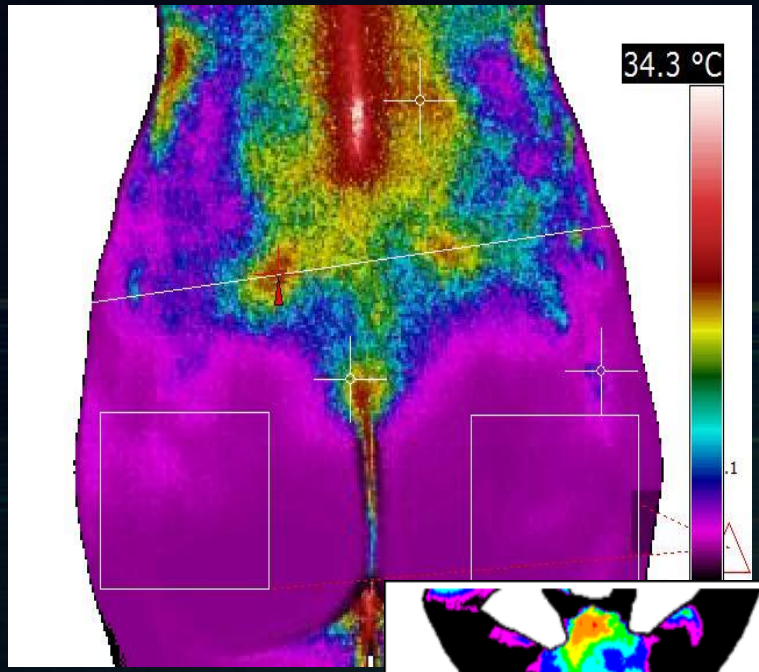
Pain Referral Patterns
From Lumbosacral and Pelvic Joint Ligaments

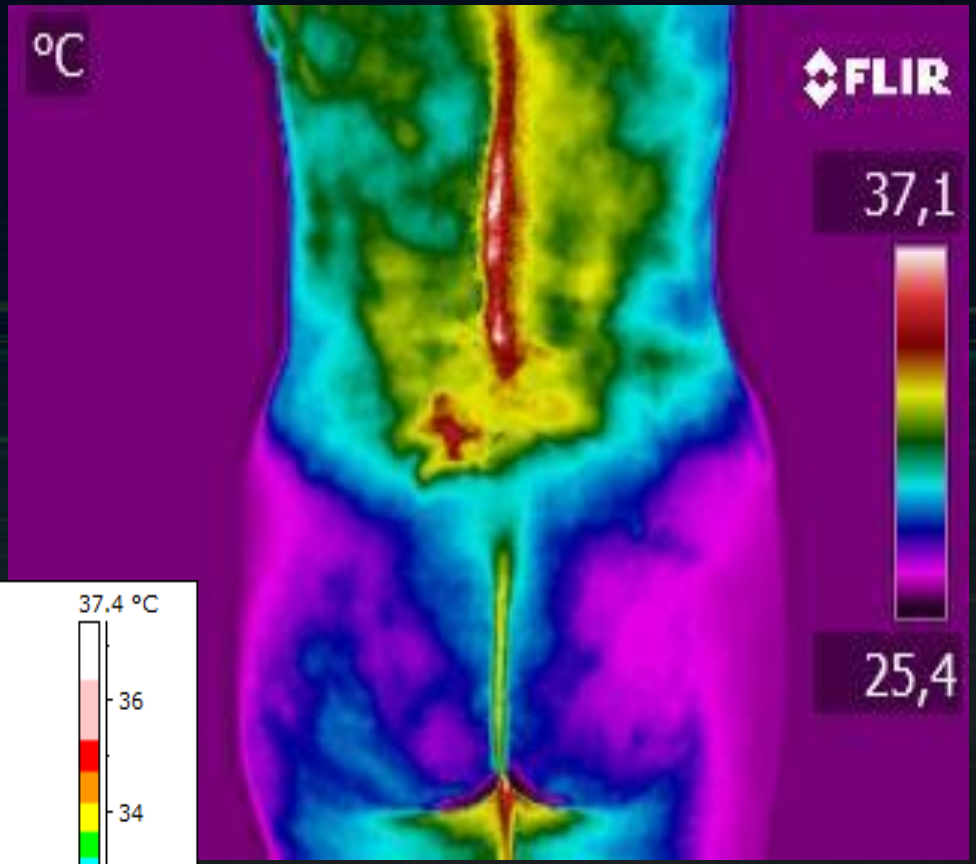
Abbreviation	Ligament	Referral Pattern
IL:	Iliolumbar	Groin, Testicles, Vagina, Inner Thigh
AB:	Posterior Sacroiliac (upper two-thirds)	Buttock, Thigh, Leg (outer surface)
D:	Posterior Sacroiliac (lower outer fibers)	Thigh, Leg (outer calf) Foot (lateral toes)—Accompanied by Sciatica
HP:	Hip—Pelvic Attachment	Thigh—Posterior & Medial
HF:	Hip—Femoral Attachment	Thigh—Posterior & Lateral Lower Leg—Anterior & into the Big Toe & Second Toe
SS:	Sacrospinus & Sacrotuberus	Thigh—Posterior Lower Leg—Posterior to the Heel
SN:	Sciatic Nerve	Can Radiate Pain Down the Leg

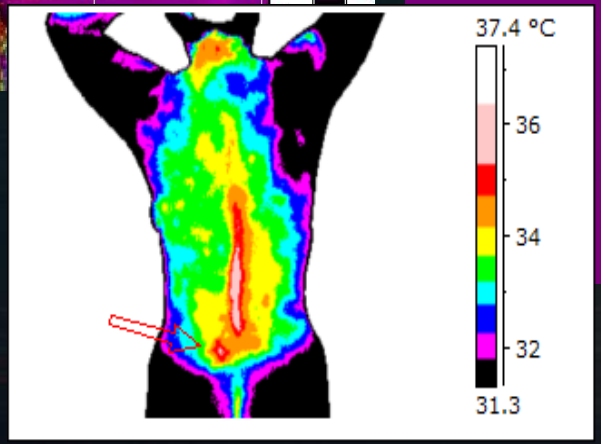
Ligament Referral Pain Patterns from Structures

Sacroiliac dysfunction

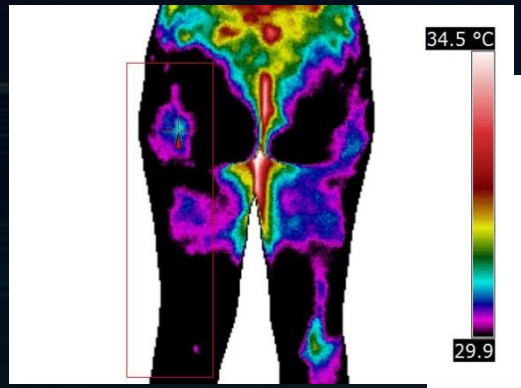


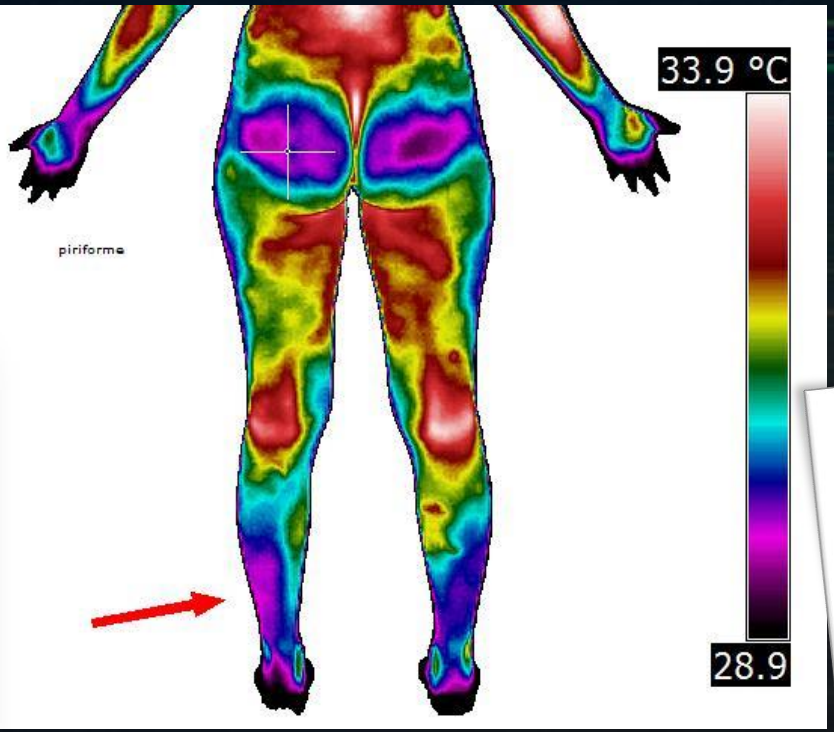

34.3 °C

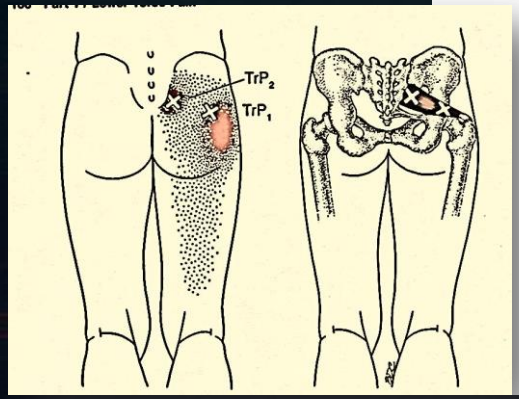

°C
FLIR
37,1
25,4


37.4 °C
36
34
32
31.3

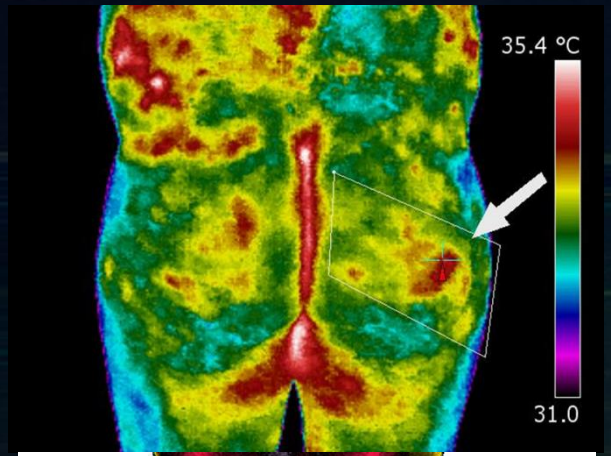
Piriformis syndrome

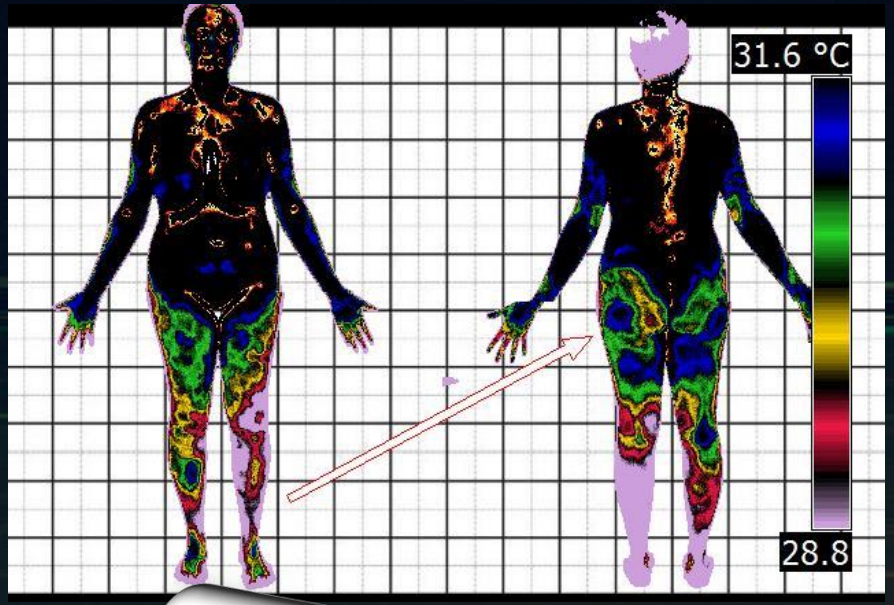




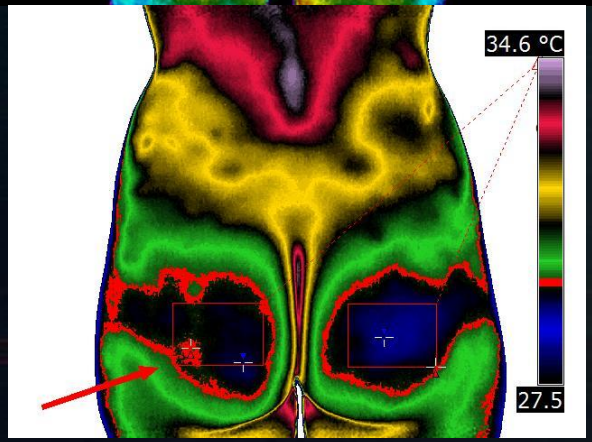


Piriformis


35.4 °C
31.0

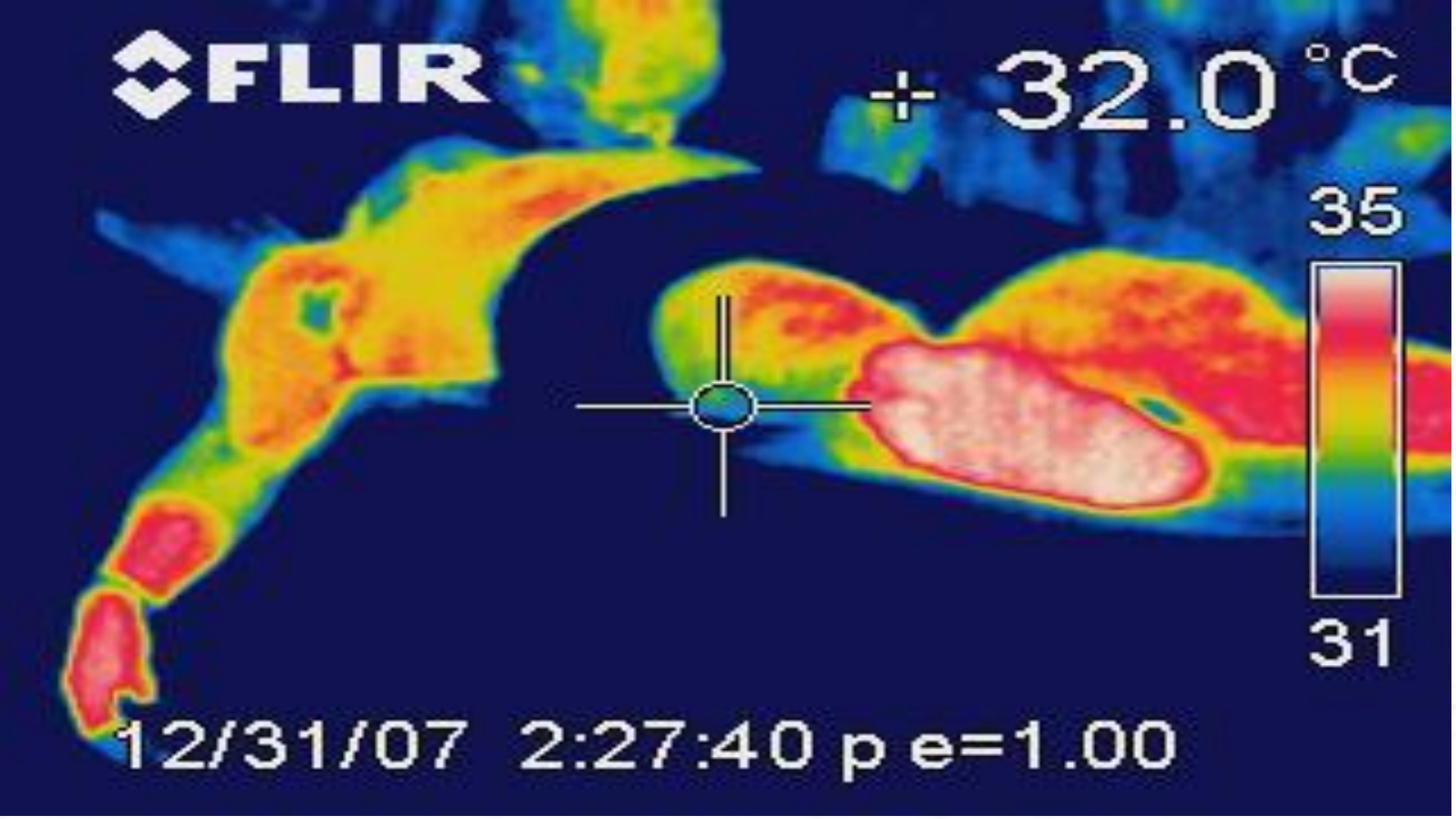

31.6 °C
28.8


Músculo Piriforme
Nervo
Ciático

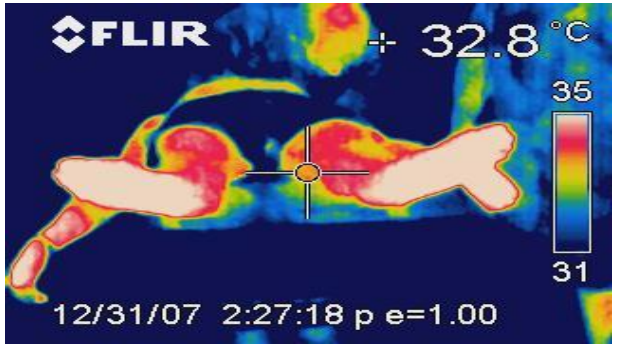

34.6 °C
27.5

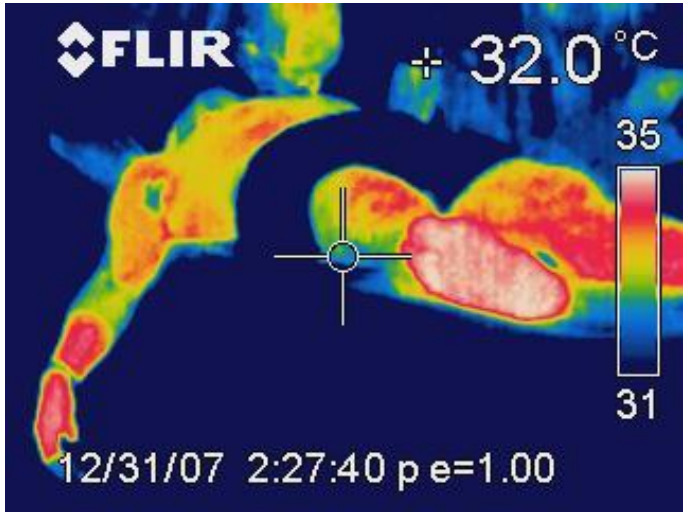

3
4
1
2


Infiltrações no Músculo Piriforme


FLIR
32.0 °C
35
31
12/31/07 2:27:40 p e=1.00

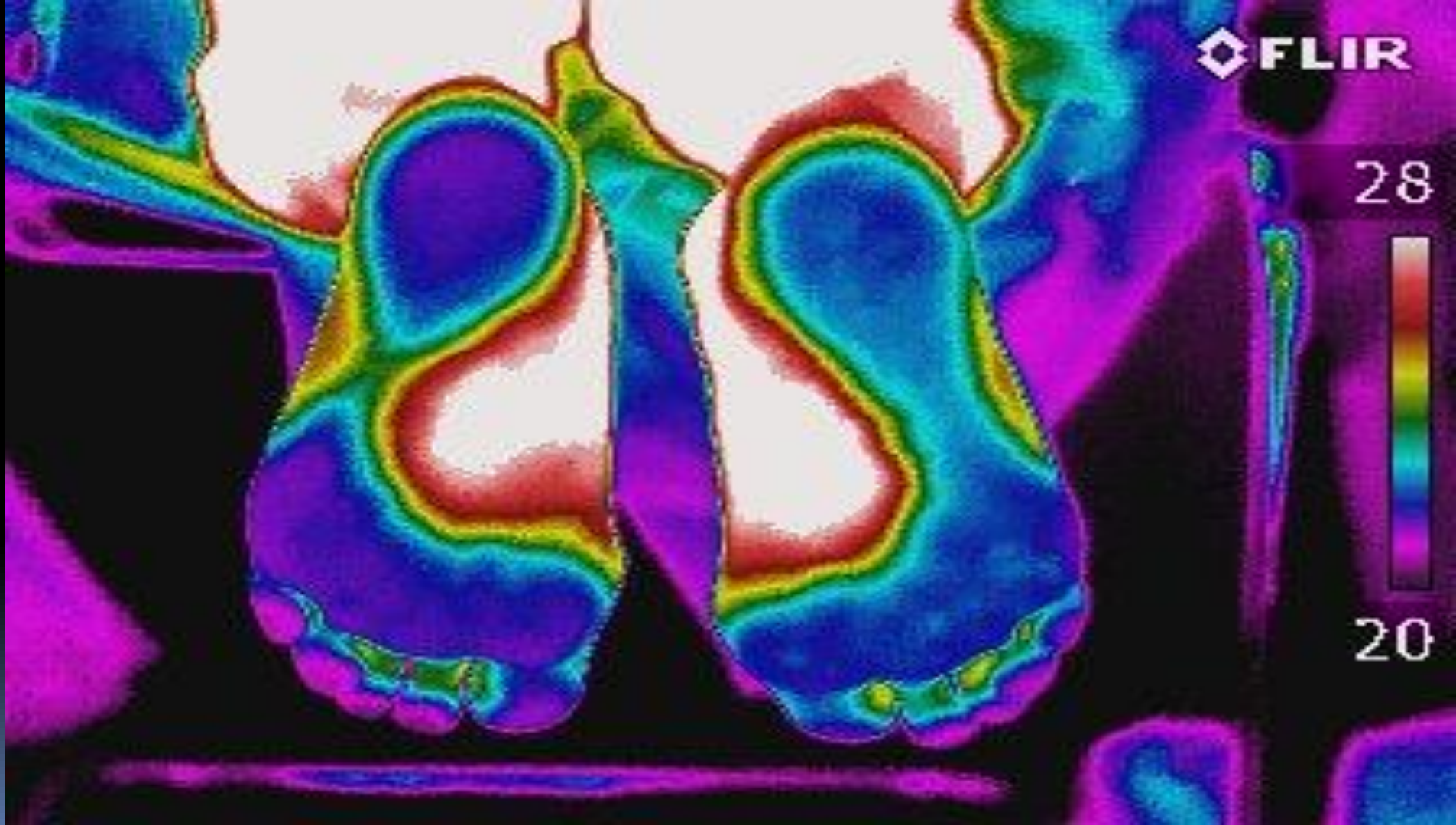
SCI – Spine Cord Injury

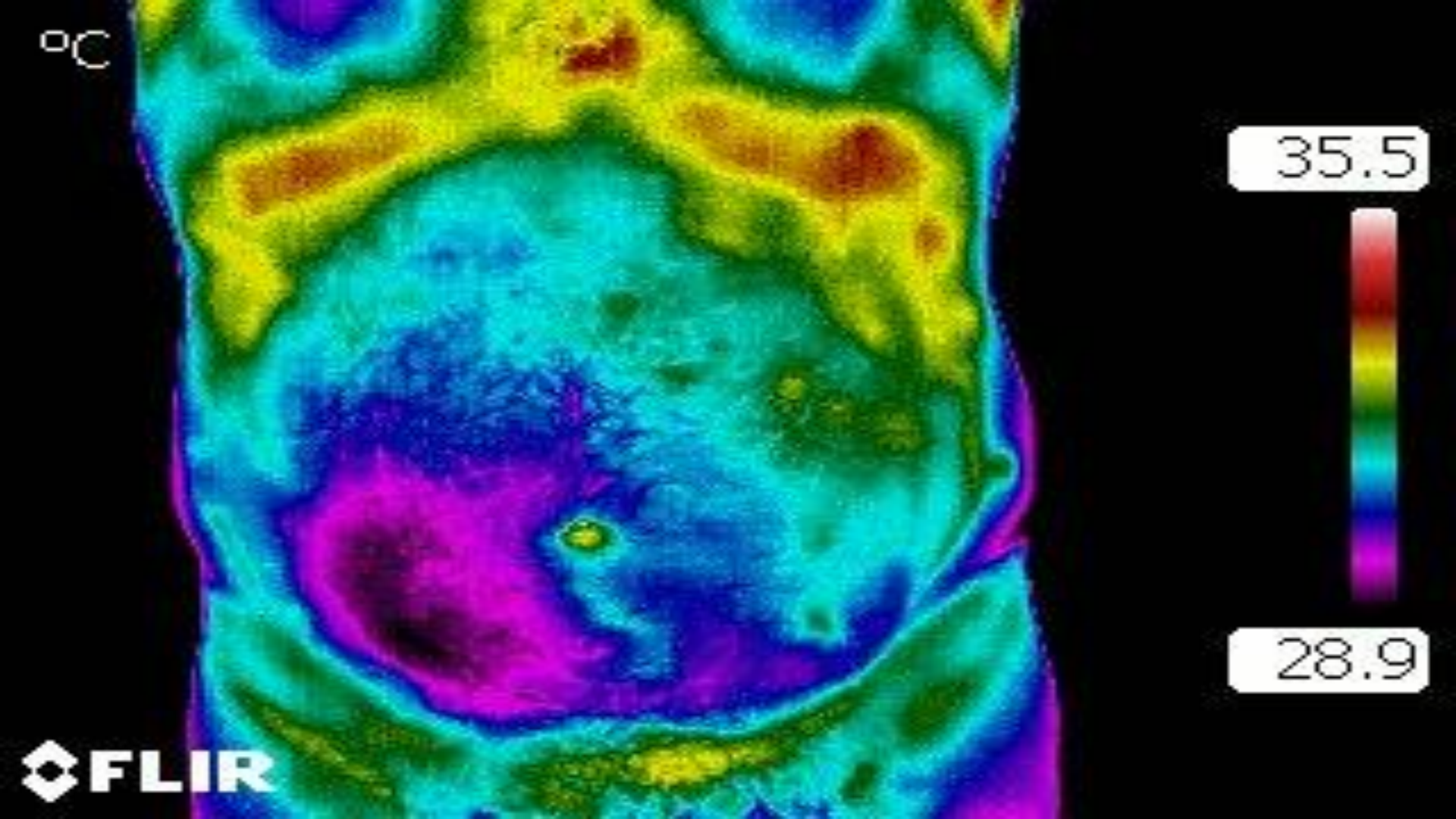


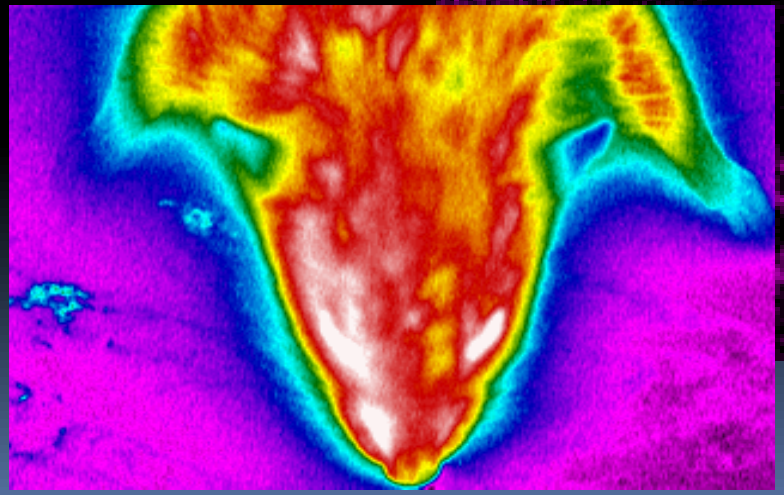


MORTON NEUROMA

PLANTAR FASCITIS

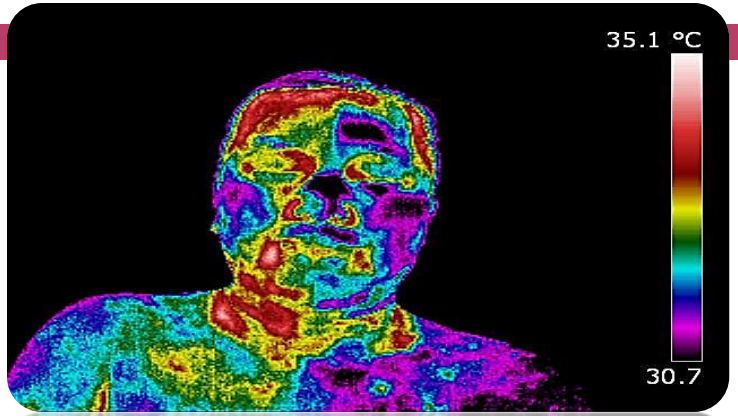

FLIR
28
20

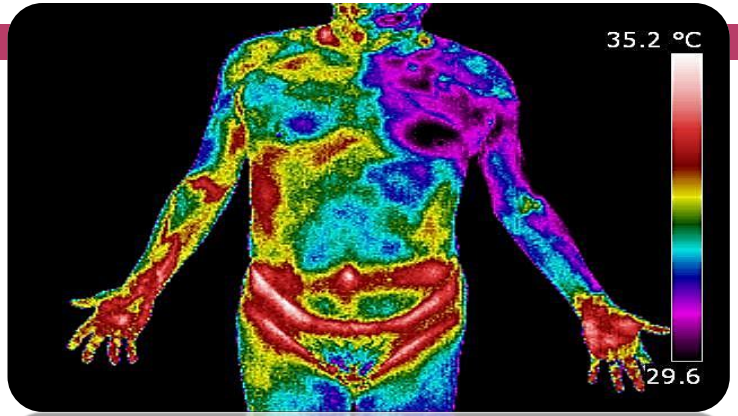

°C
35.5
28.9
FLIR

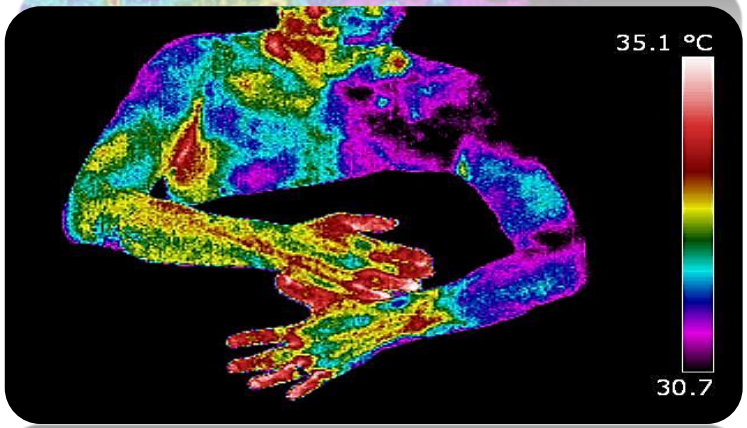

2015

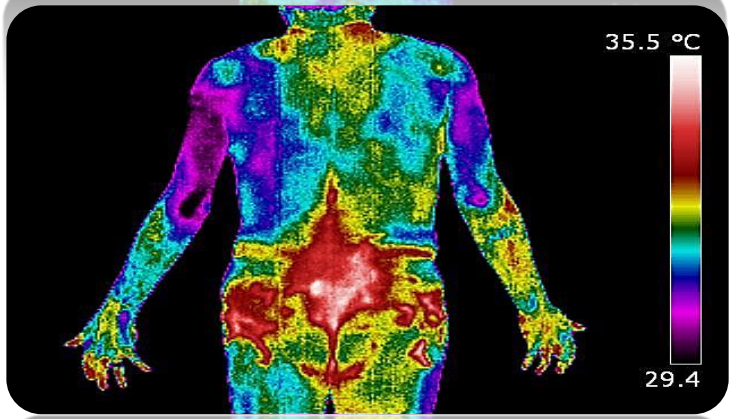

FLIR
28
20
35.9 °C
30.6

CENTRAL PAIN SYNDROME

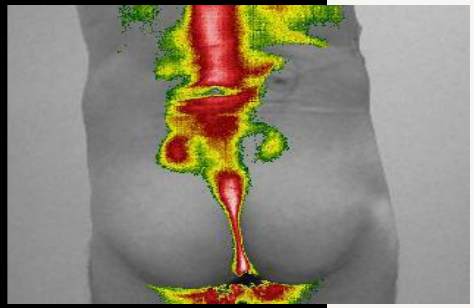




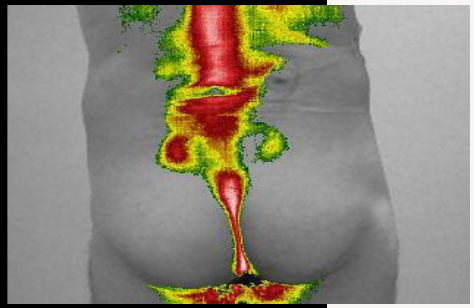




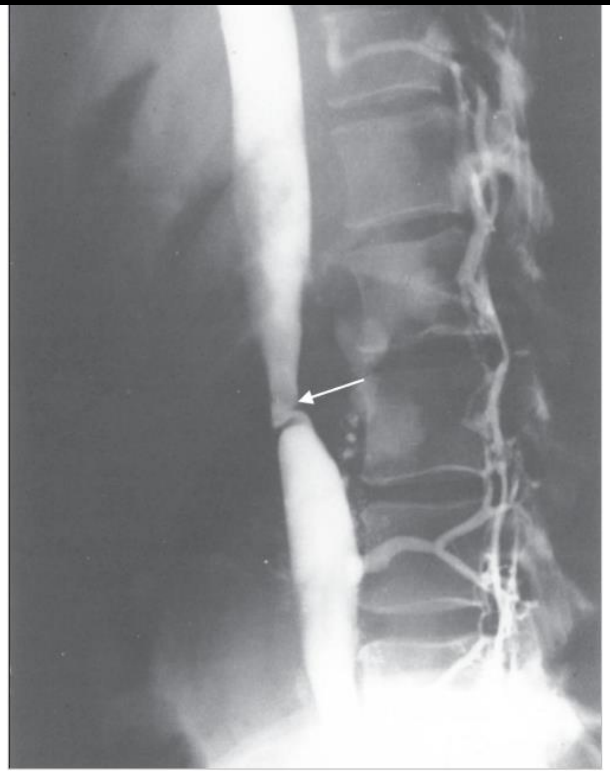
Tumor Compression (metastasis)



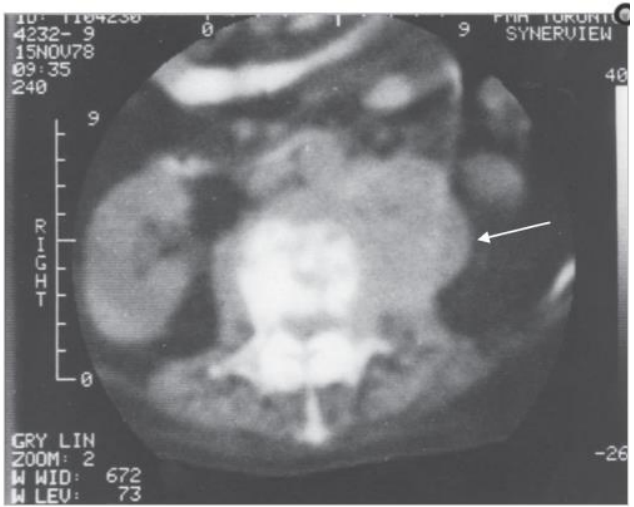
Hyper-radiation of extremities as the first manifestation of retroperitoneal tumors that provoke hyper-radiation of limbs (**Evans's Sign**)



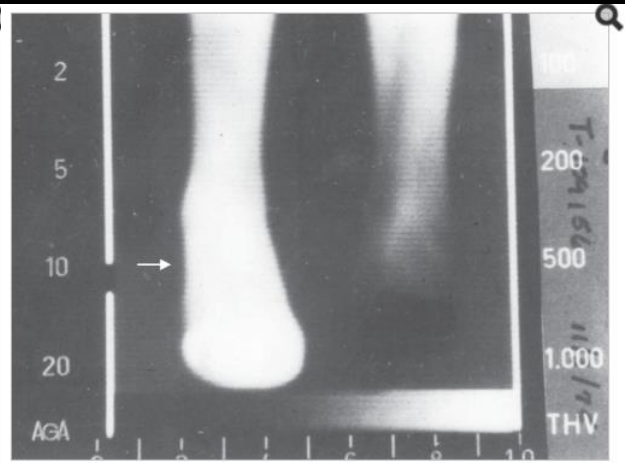
HOT FOOT SYNDROME



Venography in the hot foot syndrome due to cancer showing deviation of the inferior vena cava due to recurrent tumour (arrow)



An early, first-generation computed tomography scan (1978) showing a paravertebral tumour in the retroperitoneal space (arrow) in a patient with the hot foot syndrome



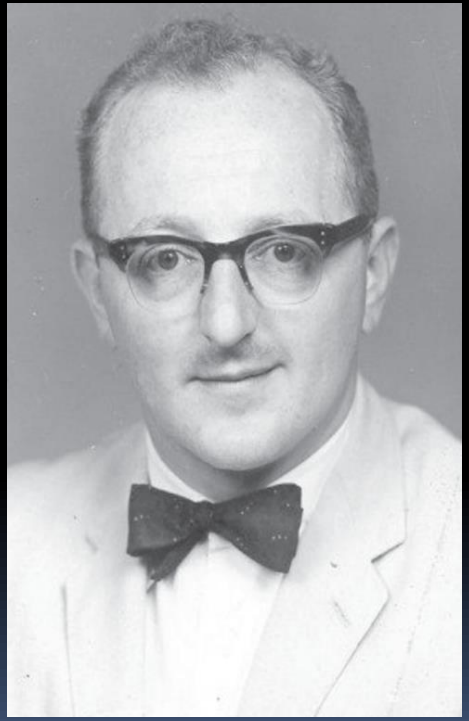
Thermography in a case of the hot foot syndrome substantiating a warmer right foot

Evans and Watson. The hot foot syndrome: Evans' sign. Pain Res Manag. 2012 Jan-Feb; 17(1): 31–34.

HOT FOOT SYNDROME

TABLE 1
The hot foot sign: Retroperitoneal disease according to age (n=86)

Age, years	Malignant (n=75)	Nonmalignant (n=11)	Total (n=86)
31–40	9	3	12
41–50	23	–	23
51–60	19	4	23
61–70	19	3	22
71+	5	1	6



Dr Ramon Evans (1932–2007)

Evans and Watson. The hot foot syndrome: Evans' sign. Pain Res Manag. 2012 Jan-Feb; 17(1): 31–34.

HOT FOOT SYNDROME

TABLE 2
The hot foot syndrome: Interval from first treatment to pain onset in the cancer group (n=75)

Interval	n
1–12 months	25
13–24 months	11
25–36 months	11
37–48 months	8
49–60 months	7
>60 months	10
Not known	3
Total	75

TABLE 3
The hot foot syndrome: Sites of pain (n=86)

Site(s)	n
Lateral, posterior, upper and/or lower leg	66
Low back, sacroiliac	10
Ankle, foot	6
Chest	3
Perineum	1
Total	86

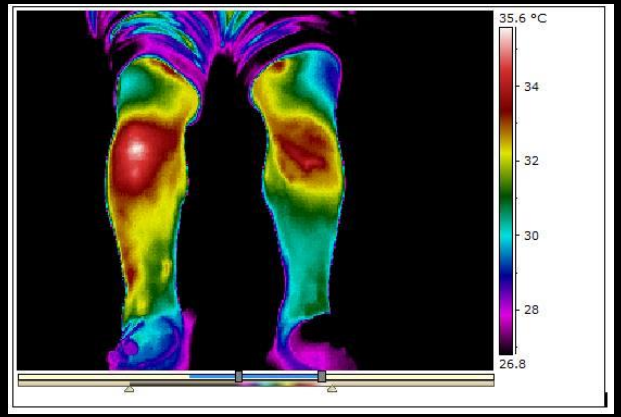
TABLE 4
The hot foot syndrome and primary tumour

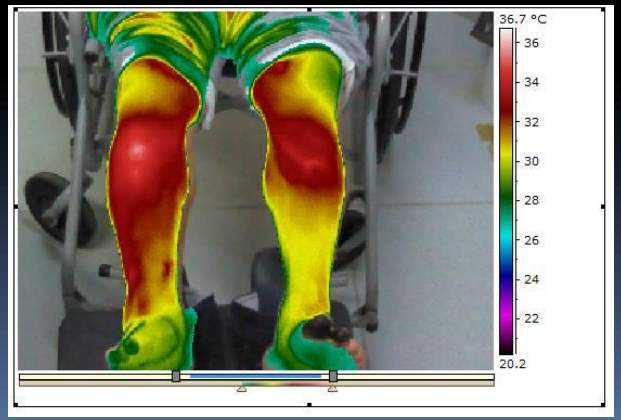
Site	n
Pelvic	
Cervix	39
Bladder	3
Prostate	2
Rectum	2
Ovary	1
Abdomen	
Colon	3
Kidney	6
Other	15
Double primaries	4
Total	75

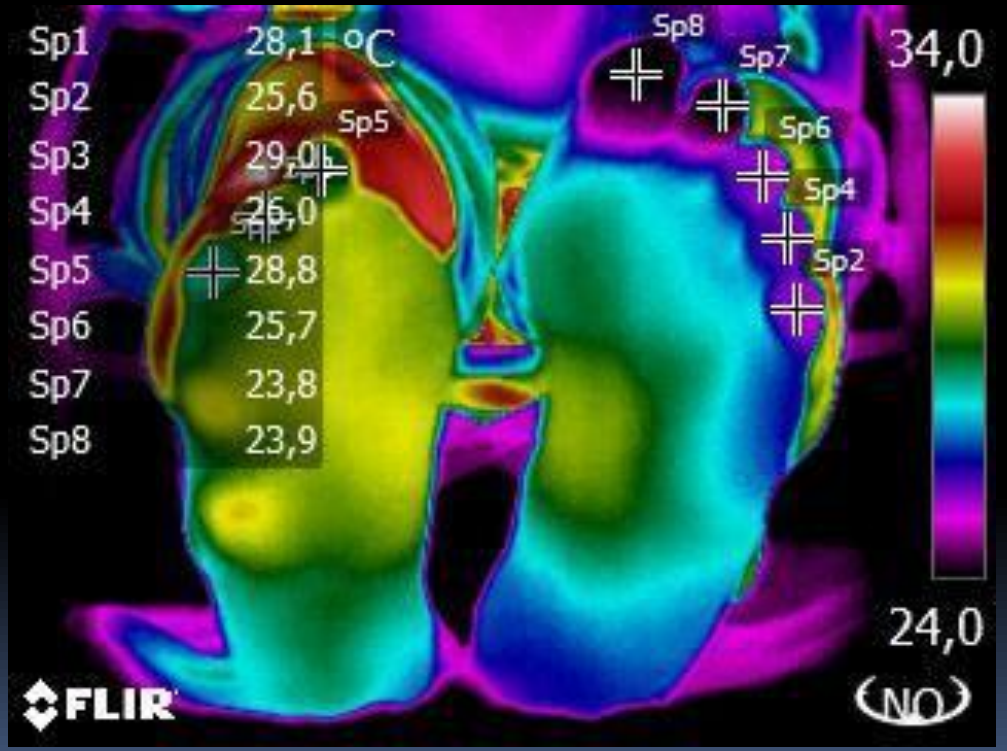
Evans and Watson. The hot foot syndrome: Evans' sign. Pain Res Manag. 2012 Jan-Feb; 17(1): 31–34.

Vascular disease

"Boot" sign but
Normal distal thermal gradient IR signatures



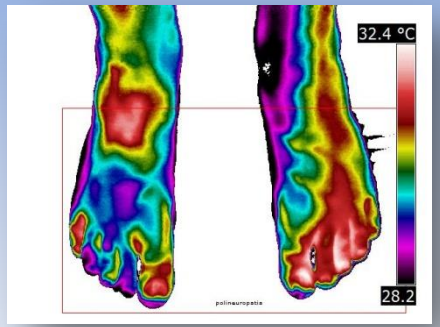




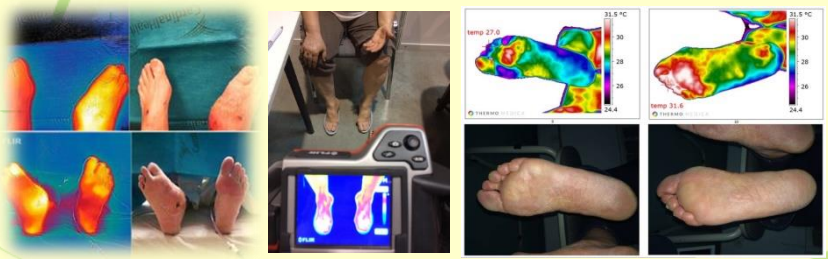
(5) CONCLUSION

- It is possible to implant a solid ulceration prevention program with thermography:
  - Reduction from 20% to 2% the probability of ulceration
  - Individual - Customized
  - Population Screening
- Medical thermologists can be trained do distinguish thermal neuropathic patterns by CST:
  - CRPS
  - Radicular L5 / S1
  - Others
- EARLY INTERVENTION: We can make a revolution in neuropathic evaluation
- A neuropathy studies redesigned by thermography

and do thermography



Our next generation will not suffer from diabetes depends of how fast we will do our job.



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