

Introduction to Diagnostic Thermology

가

가

가 가

2001 9 가 .

, :

/

part 1

I.

1.

2.

3.

(1)

(2)

(3)

(4)

4.

(1)

(2)

-

(3)

-

(4)

I- /

II

III

Thermatome

5.

(1)

(2)

(負荷)

II.

- 1.
- 2.
3. (脊髓)
- 4.
- 5.
- 6.
- 7.
- 8.
- 9.
- 10.
- 11.
- 12.

III.

V.

IV.

Part 2

I.

I.

1. 1)

. B.C17
. , B.C. 400
1°C
1592 Galileo Galileo가
17 1654
Ferdinand II Grand Duke of Tuscany
17 , 1871 Carl
Wunderlich Leipzig
10,000 "On the Temperature in Disease: A Manual of
Medical Thermometry"
가
1825 Seebeck 19
. 1934
J. D. Hardy (Emissivity) 1 가
가 , 2 가
가 가
1948 Leo Massopurt
가
. 1970 가 1985
Mills (Spinal Stenosis) (Low Extremities)
. 1980
0.02°C 가 가
가
1990
가 가 가
가 가 가

2.

2)

(Digital Infrared Thermography Imaging, Tele-infrared Thermography Imaging)

(光學系)

(,) .>?

(1)

(黑□)

(力學)

()가 0 K° 가 (結晶格子) 가 가

(入射)

(黑□)

1)

() , 1 (Kirchhoff)

가

가

1.0

2)

가 가 가 T(K°) 가 , W) λ(μm) 가 (Plank Equation)

$$W = \varepsilon \frac{2\pi h c^2}{\lambda^5} * \frac{1}{\exp(hc/\lambda kT) - 1} \text{ ----(1) 식}$$

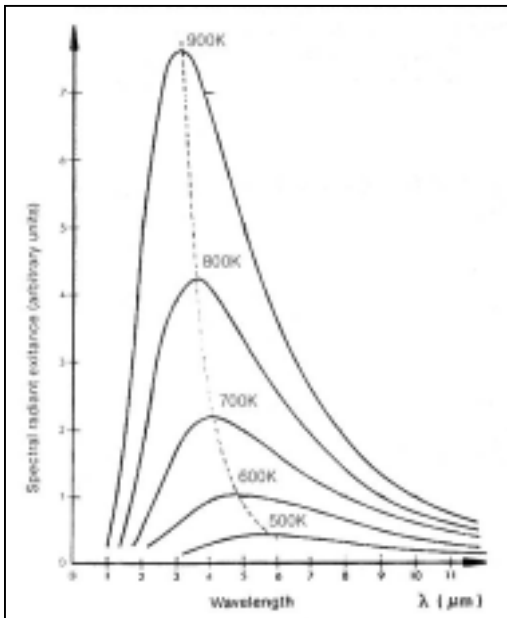
ϵ (1.38×10⁻²³J/K), h (6.63 ×10⁻³⁴Js), c , k

3)

M_λ 가 λ_{max} 가

$$\lambda_{max} = 2,898 \times 10^{-6} / T \text{ (m)} \quad \text{--- (2)}$$

, (1)



(1) The spectral distribution of radiating energy from black body

4)

, 가 T(K), M

$$M = \sigma T^4 \text{ (W}\cdot\text{m}^{-2}\text{)} \quad \text{--- (3)}$$

(Stefan - Boltzmann), σ Stefan - Boltzmann, $\sigma = 5.673 \cdot 10^{-8} \text{ (W}\cdot\text{m}^{-2}\cdot\text{K}^{-4}\text{)}$

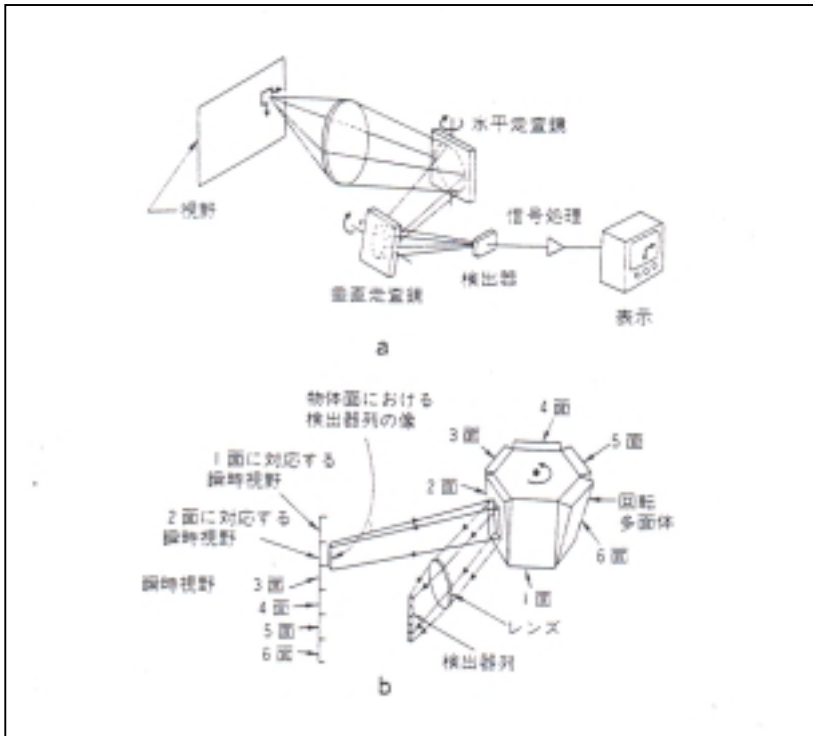
M 가 T 가

5)

가 ,
 가 . ϵ
 $\epsilon(\lambda)$
 $\epsilon \neq \epsilon(\lambda)$, $\epsilon = \epsilon(\lambda)$
 (1) (3)
 $\epsilon(\lambda)$, ϵ
 0.98~1.0
 가 . , ,

(2) (Infrared Thermography Imaging System)

1 FRAME TIME 1
 1/20 - 1/60
 (Infrared detector) HgCdTe(MCT: Mercury Cadmium Telluride) InSb(Indium Antimonide)가 가 (Photon detector)
 가 ,
 (Peltier Effect) (TEC) 가 ,
 (Sterling Cooling)



(2) (a) (b)
 (a: Friedrich, 1980, b: Wooddrough, 1982)

2-a , (走査, Scanning)

(Signal)

CRT

2-b

(走査)

가

(Multi-element)

가

(Uniformity)

SPRITE (Signal Processing in the Element)

3)

가

(3)

Infrared FPA(Focal Plane Area)

Area Sensor

(Scanning)

InSb

가 512x512

1 30

μ -bolometer FPA가

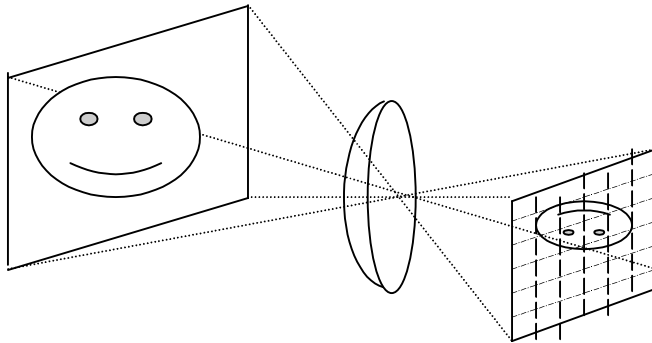
327x245,

(NETD; Noise Equivalent Temperature Difference, Temperature Resolution) 0,05 °C

(Frame Rate) 1 30

가

가



(3) FPA

1) 1 1 , “Physical Properties of Infrared Light in Biomedical Application”.

2) Transactions on Medical Imaging Vol.17 No.6 December 1998, “A Reappraisal of the Use of Infrared Thermal Image Analysis in Medicine.”

3.

(1)

:

25°C

(가), 가

가

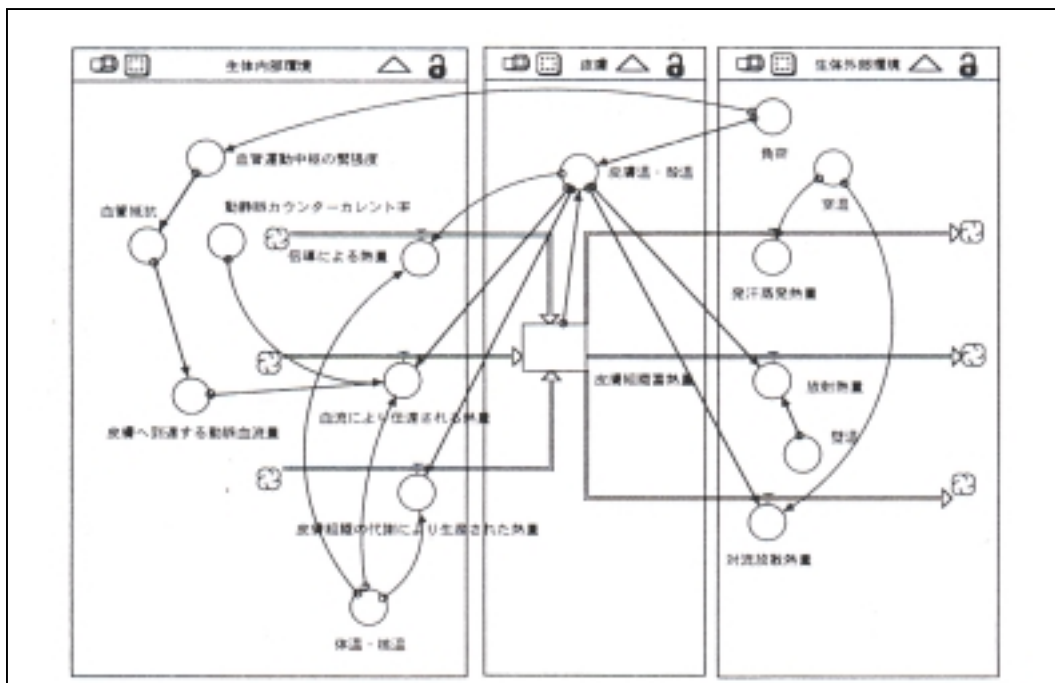
(), (

(

), (), ()

가

(1).



1.

(STELLA Research : High Performance Systems, Inc.

)

(2)

(heat stripe)

(heat stripe)가

() 가

가

(

가

가).

가

1)

가

가

가
가

(以上)

가

가

가

가

()

2)

가

3)

가)

(cutaneous vasodilator, CVD) (cutaneous vasoconstrictor, CVC)
CVC CVD CVC
CVD non-adrenergic, purine, ATP,
non-cholinergic Substance P, 가 , 가

) (Humoral factor)

가 가 , 가

a.

* Epinephrine norepinephrine -

* Renin -angiotensin - norepinephrine

b.

가

가

bradykinin

c.

) 가 가 .
 42 42
 40-42 가 15 가
 가 가

4) (CVC)

가) CVC

1. , CVC 가 1)
 CVC , (PaO₂, 20 Torr),
 , 가

1.

(PaO ₂ >30 Torr)	(PaO ₂ <20 Torr)	
()	()	

CVC , (PaO₂, 30 Torr), ,
 (, PaO₂,), (,)
 ,
 CVC

)

가
 1905 Muller가 가
 가

Walther

2)

가
 (regional differentiation of sympathetic efferents)

가 가

가

가

(CVC), (CVD) (sudomotor nerve: SM) CVC CVC
 (pilotmotor nerve: PM) SM
 SM, PM
 microneurography 가
 J. nig (spinal functional unit) 가 가
 CVC , SM , CVC ()
 J. nig 가 가 가
 3)

(3)
 가 가 (sudo-motor) 가
 가 가
 가

1) ()
 (37) 「Jar」 + 「radiator」 가
 가
 가 ()
 가 (가 가) 가 가
 가 가 가

가)
)
) ()
)
)

異常 異常 ()

2) . .

가) ()
(ASO, TAO) ()

Taylor³⁾ angiosome 가 가 가
가 가 level

) 가 () , 가 ,

a)

b)

1 , 2

가 가

c)

(dermatome) 가 가

ㄱ)

ㄴ)

가

1 (Th1 L3) 2.3 가

가 가

가 가 Th1 , L3 , a) 가 (global)

4). b) 가 가

d) 가

) 가

motor neuron disease 가

dermatome 가 가 가

(, ,)

3)

(4)

0.98
 (較正) ()
 3
 6
 5)
 가 가 가 가 가
 가 11 가 가 가
 가
 (發汗)
 25

核溫)
 가 가

1) Thermatome :

가 (異常)
 ()
 (1).

1 異常 ()

	(閉塞),	()
	(脊髓)	
(serial real time)		(Thermal recovery)

1)J nig W: Organization of the lumbar sympathetic outflow to skeletal muscles and skin of the cat hindlimb and tail. Rev Physiol Biochem Phamacol. 1985;102:119 -213

2)Walther OE,Iriki M. and Simon E: Antagonistic changes of blood flow and sympathetic activity in different vascular beds following central thermal stimulation.II. Cutaneous and visceral symphathetic activity during spinal cord heating and cooling in anesthetized rabbits and cats. Pflugers Arch.1970;319:162 -84.

3) - -Biomedical Thermography,6 1 -7,1986.

4) . Biomedical Thermography. 7(1),104 -107, 1987.

5) : Human physiology. 1 st ed. , , 1999;pp712 -718.

4.

(1)

가 가 가 .
 ()
 < > ()
 가 .
 가 가 가 .
 가 가 .

1)

() (37)
 (制御系)가 . (制御系) ()
)
 (散熱) 가 (發汗)
 ()
 ()

, , , ()
 , , , , , , , , ,
 (), ,

가 .
 가 ()
 가

가
 가 가
 가 .
 (가)
 ()
 가)
)

) (蒸散) 3)
가)))
3 가))
가)
가
가
가 가
가 가
1)
15 가

1. 53 /
TOTAL ; N=63 (RIGHT HANDED : N=49, LEFT HANDED : N=4)

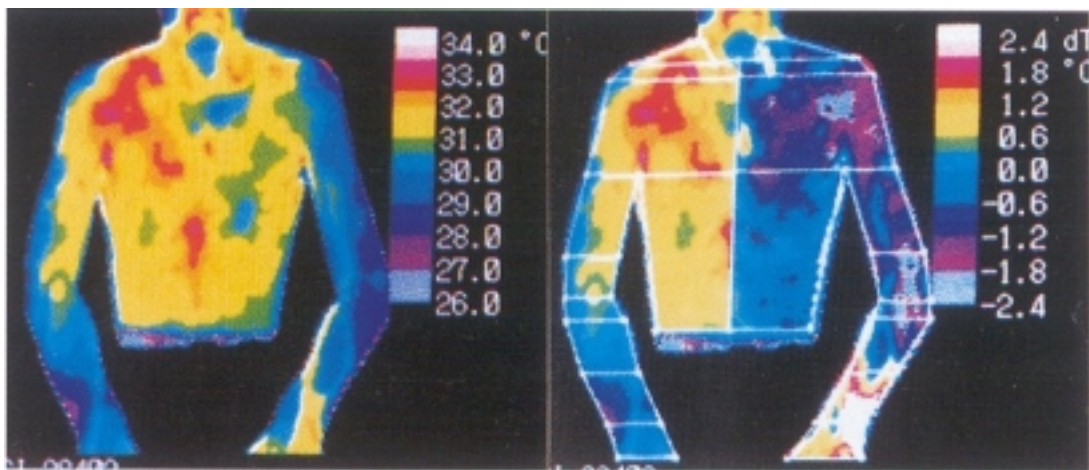
POSITION	BODY SURFACE TEMP.				TEMP. DIFFERENCE (R-L)			
	LEFT SIDE		RIGHT SIDE		TOTAL		LEFT HANDED	
	MEAN	STD.	MEAN	STD.	MEAN	STD.	MEAN	STD.
1	33.6	0.92	33.7	0.89	0.06	0.15	0.13	0.11
2	33.3	0.59	33.4	0.56	0.15	0.23	-0.03	0.04
3	33.0	0.69	33.1	0.63	0.18	0.21	0.05	0.21
4	33.2	1.17	33.3	1.16	0.13	0.27	-0.03	0.25
5	33.4	0.90	33.4	0.93	0.03	0.12	0.08	0.08
6	32.8	0.65	32.9	0.65	0.07	0.20	-0.13	0.08
7	33.2	0.68	33.2	0.68	0.03	0.20	0.05	0.18
8	33.9	1.02	34.0	0.96	0.08	1.25	0.03	0.23
9	33.4	0.68	33.6	0.63	0.18	0.27	-0.2	0.17
10	--	--	--	--	--	--	--	--
11	32.6	0.61	32.7	0.65	0.1	0.17	0.03	0.08
12	32.5	0.49	32.5	0.50	0.04	0.14	0.05	0.17
13	31.3	0.60	31.4	0.62	0.04	0.20	-0.13	0.11
14	32.9	0.59	32.9	0.59	0.04	0.15	0.18	0.08
15	32.7	0.52	32.7	0.50	-0.06	0.14	-0.15	0.05
16	32.7	0.65	32.7	0.63	0.09	0.18	0.15	0.21
17	32.7	0.53	32.7	0.53	0.10	0.18	0.03	0.04
18	32.6	0.54	32.7	0.55	0.11	0.14	0.20	0.07
19	32.4	0.48	32.5	0.46	0.06	0.17	0.00	0.17
20	31.4	0.63	31.5	0.61	0.06	0.21	-0.05	0.15
21	31.2	0.61	31.2	0.63	0.04	0.18	0.05	0.15
22	33.2	1.35	33.4	1.21	0.15	0.44	-0.08	0.23

TOTAL : N=53. (RIGHT HANDED : N=49. LEFT HANDED : N=4)

가 /
 (A) 가
 () , (B)
 가
 , (C)
 (Region of interest-ROI)

가
 가
 가
 가
 가
 false negative가

2. / (差) 3)



3)

/
 (/) 가 / 가
 가 가

2.

/ , Uematsu ⁴⁾

Skin-temperature Differences between Sides of the Body			
Body segment	Cutaneous Sensory nerves and segments measured	Mean average temperature differences	
		(°C)	S.D.
Forehead	Trigeminal Nerve(V-1)	0.12	0.093
Cheek	Trigeminal Nerve(V-2)	0.18	0.186
Chest	Intercostal(T1-T7)	0.14	0.151
Abdomen	Intercostal(T7-T10)	0.18	0.131
Neck(Posterior)	Cervical(C2-C5)	0.15	0.091
Thoracic, paraspinal	Post-Cutaneous(T2-T12)	0.15	0.092
Lumber(Back)	Dorsal div.spinal(T11,12,L1,2,3,S1,2,3)	0.25	0.201
(Trunk Average)		(0.17)	(0.042)
Scapula	Dorsal div. spinal(T1,5)	0.13	0.108
Arm(Biceps)	Med. antebrachial(C8,T1)	0.13	0.119
(Triceps)	Dorsal antebrachial, axillary(C5-6)	0.22	0.155
Forearm(Medial)	Med. antebrachial(C8,T1)	0.32	0.158
(Lateral)	Lat.antebrachial(C5-6)	0.23	0.198
Palm(Lateral)	Median(C6,7,8)	0.25	0.166
(Medial)	Ulnar(C8,T1)	0.23	0.197
Thigh(Anterior)	Ant. fem. cutaneous(L2-3)	0.11	0.085
(Posterior)	Posterior cutaneous(S1,2,3)	0.15	0.116
Knee(patellar)	Ant. fem. cutaneous(L2,3)	0.23	0.174
Popliteal	Post. fem. cut., Com. Peron.(L4-5,S1-2,3)	0.12	0.101
Leg(Anterior)	Saphenous, sup. Peroneal(L3,4,S1-2)	0.31	0.277
Calf	Sural, Saphenous(L3,4,S1-2)	0.13	0.108
Foot(dorsal)	Peroneals(L4-5,S1)	0.30	0.201
Heel	Tibial(S1-2)	0.20	0.220
(Extremities,Average)		(0.20)	(0.073)
Finger(Tips),*Average	Median & ulnar(C5,6,7,8,T1)	(0.38)	(0.064)
Toe(Tips), **Average	Median, lateral, planter(L4,5,S1-2)	(0.50)	(0.143)

* Five segments, but only average is given here
 ** Five segments(big toe and four others), but only average is given here

/ 가 0.3~0.4 °C
 . 2 Uematus /
 4)5) / 가 가
 0.32 °C
 0.30 °C 가 0.30 °C (가 . 가),
 가 0.277 °C 0.2 °C .

(3)

II

(Thermatome)

1) (angiologic thermatome)

(異常)
TAO ASO

가

가 가

가

가

가

(吻合)

異常

가

(吻合)

가

가

(Structural Angiologic Thermatome)

가

(functional angiologic thermatome)

가

가

2) (dermatomal thernatome)

(Dermatome) (帶狀) (neuro-dermatome)

가

가

(椎間板)

가

< >

(手根管)

(根)

(星狀)

(空

洞症)

(空洞)

(.crush injury)

가

3) (myotomal thernatome)

(myotome)

10mm

(穿通枝)

4) (metabolic thernatome)

異常

(Hyper-thermal Area)

5

가 가

가

가

5) (負荷)

가

가

가

異常

가

異常

가

異常

가

(serial real time)

(虛血)

가

가

가

가

(4)

III

1)

15 °C 40 °C
 0.1 °C 8bit 0.1°C
 x256=25.6°C 가 40 °C
 14.4 °C 가 0.05 °C 12.8 °C
 25 °C 37.8 °C 가

→

/

5)6)

/

/

0.4

가 0.4

/

異常

(椎間板)

2)

Clark Ring

가 가
(差分)

가

가

→

(heat stripe)
(heat stripe)

가

(heat flare)

(heat splitting)

3)

(負荷)

가 가

가

가

異常 가

→

(serial real time)

(serial real time)

가

가

가

4)

....

TV Frame rate

off -pump (

)

(coronary by -pass)

5)

→

()

가

(thermal recovery)

6) 가

가)

) 가

가

(開大) 가
가

)

)

()

(

) 가

- 1) Kunihiko Mabuchi, Hirokazu Genno, Kazuo Matsumoto, Tsuneo Chinzei, Iwao Fujimasa :
Autonomic thermoregulation and skin temperature : importance and role of deep body temperature in the determination of skin temperature. The Thermal Image in Medicine and Biology. (K. Ammer, E.F.J.Ring eds), UHLEN VERLAG VIENNA, Vienna .1995; 12-129.
- 2) 満洲邦彦, 池川志郎, 松永徹志, 藤正 巖, 渥美和彦 : 正常例における体表温の左右差の検討, **Biomedical Thermography** 17 (1) : 66-68, 1987
- 3) Kunihiko Mabuchi, Tsun Chinzei, Iwao Fujimasa, Shigehiko Haeno, Kiyoji Motomura, Yusuke Abe, Takumi Yonezawa : Evaluating Asymmetrical Thermal Distributions through Image Processing., IEEE Engineering in Medicine and Biology Magazine .1998;17(4) : 47-55.
- 4) Sumio Uematsu : Symmetry of Skin Temperature Comparing One Side of the Body to the Other., Thermology. 1985;1(1) : 4-7.
- 5) The Johns Hopkins Medical Institutions Sumino Uematsu M.D: Quantification of thermal asymmetry 1988
- 6) Park W and Bae D. K. : Comparisons of infrared thermogram, magnetic resonance imaging and eletro physiological test for patient to complain several types of pain . The korean Society of Diagnostic thermology. In press.2001.

5.

(1)
→

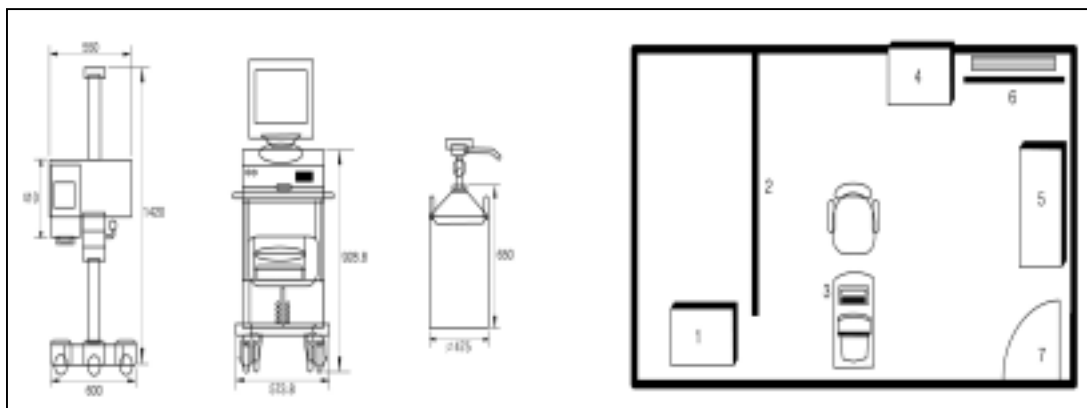
가
가

()

1)

가
i) ii) iii)
i) ii)
iii)
가
가
23-25 °C
가

가) ()



1 - 2 - 3 - , () 4 -
5 - 6 - () 7 -

)



250ml
가
가
(fog)가
가 1/3
, 250ml 6~7 1/3
250ml 100ml
(350ml
(fog) 가
가 (: 100ml 5-6 /h)
PC

)

가
가
가 1)
24 ±1 60%

2)

가)

()³⁾

1.	가	,	,	,	,
2.	3	,	,	,	()
3.	2				
4.	30				
5.		20		25°C	
6.					

()

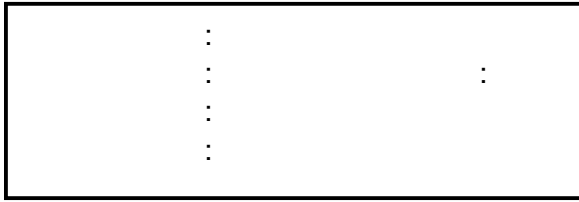
-
1. .()
 2. 가 ()
 3. 25 ,
 4. 20 .
 5. 4 .
 6. , ,
 7. EMG, 24
EMG 72 가
 8. (疼痛) (), , ,
(), , , , , , ,
 - 9.
-



) (Draw chart)

, (Draw chart)

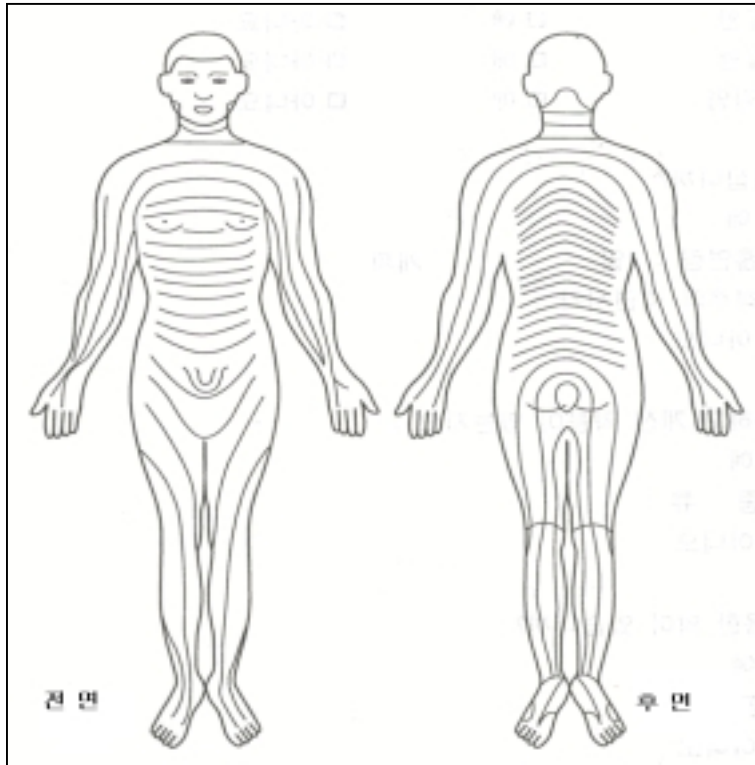
Draw chart of pain ()²⁾



: 200 . . .
:
:

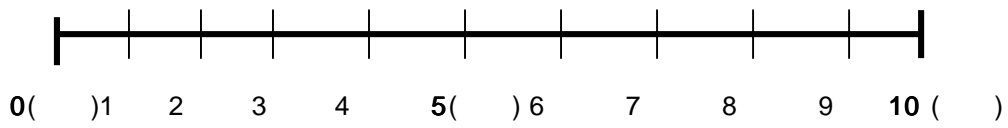
1. (: , ,)

2. 가 .



(: :)

1. , ?
2. × .) (?), (), ()

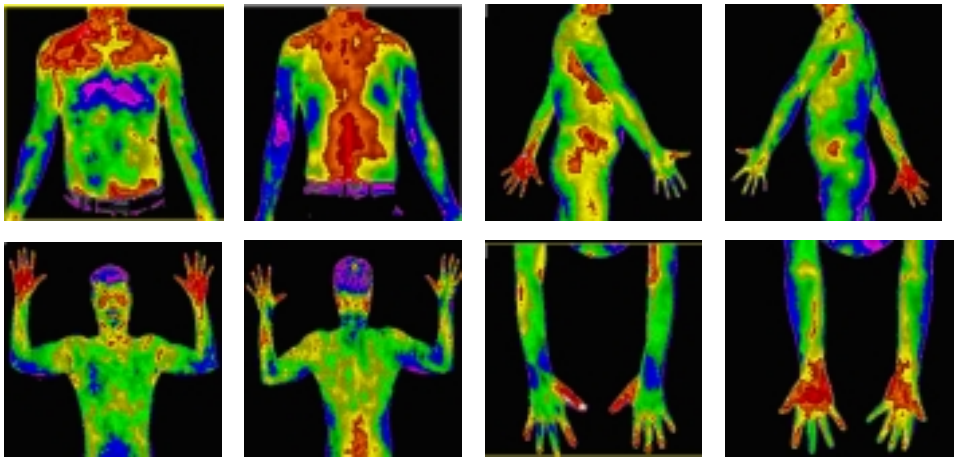


3)

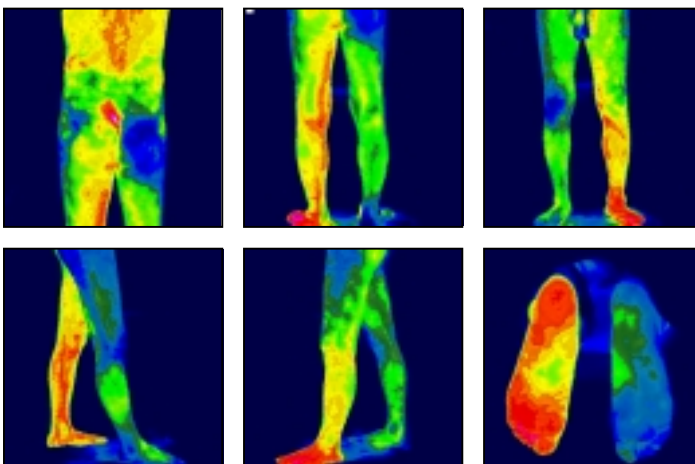
3)

가)

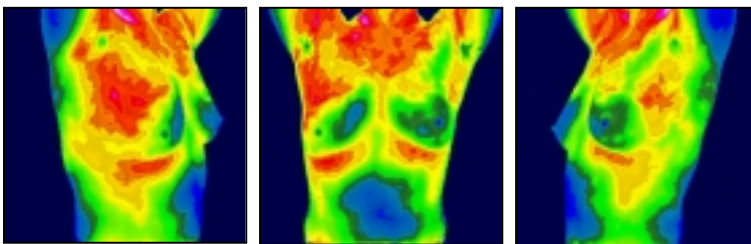
a. : / / , , / , , /
, / , / /



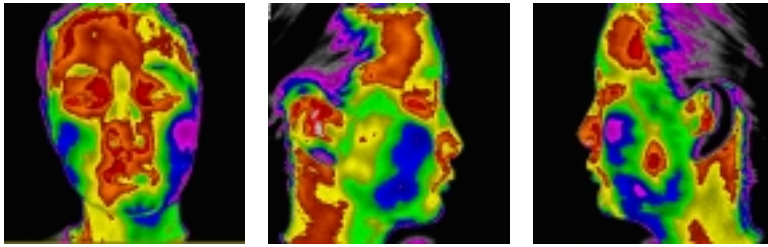
b. : / / / / /



c. 가 () : / (45) / (45)



d. (): / (90)/ (90)



)

a)

ㄱ. : 15~20 25 ± 1 °C
 ㄴ. : 2) 가 . Erikson 가
 30 가 26 ~28 °C 小川
 가 24~26 °C
 . 佐佐木 30 °C 가
 25~30 °C 가 .
 가 25 °C 가

b)

ㄱ. : 25°C 20
 ㄴ. : 가 가

c)

ㄱ. : 15~20
 ㄴ. :
 (Draw chart)

. VAS(Visual analogue scale) , Verbal Pain Score

d)

ㄱ. : 15~20

ㄴ. : 가

30~32

5 °C

가 가

e)

ㄱ. : 10~15

ㄴ. :

가

, 가 ,

가

, 가 , 가

4)

f)

ㄱ. : 15-20

가

가

ㄴ. :

g)

ㄱ. : (發汗)

가

20

5)

15

가

ㄴ. : 1 , /

(45

) 1

가

(噴霧)

h)

ㄱ. : . 가 9)

ㄴ. : , / (varicocele) 가 90%

subclinical varicocele
valsalva 가

) 4)

a)

ㄱ. , , . , , 異常 (頸部)

ㄴ. 1 70%

ㄷ. 1 5

ㄹ. 가 , /

ㄷ.

ㄹ.

가 (手指尖) 가 가 가

가

(10, 1 : 4, 30)

(45, 3)

ㅂ.

2

ㅅ.

가

(精索)

가

가

- 1) 入来正躬：生理機能画像診断 サーモグラフィ, 秀潤社：13-19
- 2) Wook Park M.D and Duck Koo Bae, M.D: Comparison of infrared thermogram, magnetic resonance imaging and eletro physiological test for patient to complain several types of pain . The korean society of Diagnostic thermology. In press..2001
- 3)
- 4) 藤正 巖：生理機能画像診断 サーモグラフィ, 秀潤社：36-39
- 5) :
: pp5 -10
- 6) 満洲邦彦 他：生理機能画像診断 サーモグラフィ, 秀潤社：32-35

(2)

1) (負荷)

가)

homeostasis

가

가

가 가

가

1.	5.
2.	6.
3. ()	(鍼灸)
4.	7.

a)

ㄱ. 25

ㄴ. 15~20

ㄷ.

ㄹ.

가

b)

(無)

가

가

c) 1)

가

가

d) 1)

가

가가

) 2)

a) 0°C 10

b) 10°C 1

c) 20°C 5

가

가

0°C 10

Raynaud's phenomenon

0 °C 10

.10°C 1

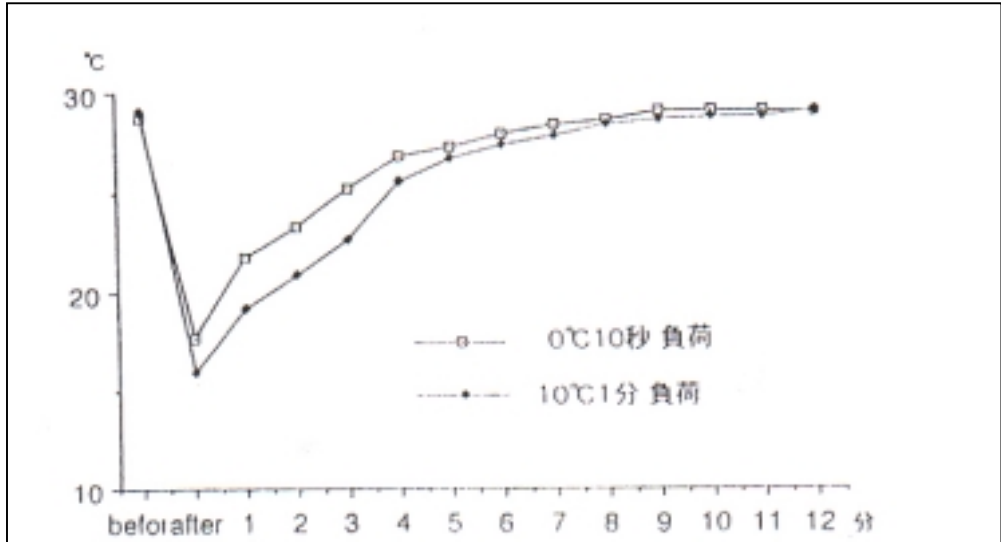
0°C

가
가

10 °C 1

0 °C 10 10 °C 1

(1)



0°C 10

5~6

100% 가

10°C 1

5~6

100% 가

가

가

가

10°C 1

0°C 10

3)4)

(再現性)

10°C 1

0°C 10

가

0°C 10

5 ~6

100% 가

10°C 1

5

6

100% 가

가

가

가

2)

가

가

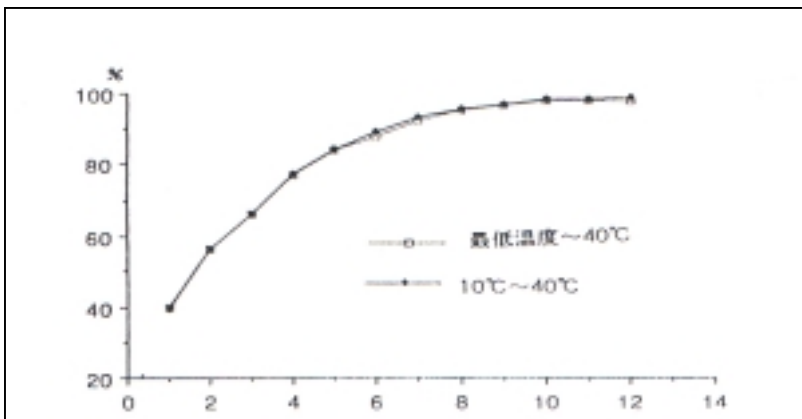
(Area)

가 가

2

2가

가



2

(Area1)

3)

가

가

(腿)

가

(가)

194 가 3) 750
 750 106 가 10
 10 (蛋白質) 106 0 °C
 가 , 6
 가 ,

28.7 ± 1.2 °C 27.5 °C
 6 82.2 ± 12.0% 70.2%
 42% 85% 6 가
 65%, 80% 5)
 가 가

- 4) 6)
 가) (造影) (Thermographic venography) (表在)
 (脂端) 42 °C
 (走行) 가
-) (Thermal recovery) (復溫)
-) (Reactive Thermography)
-) (Visual Thermography)

- 1) 後藤繁優 他：冷水負荷試験の日内変動, *Biomedical Thermology* 8 (1) : 61-63, 1988
- 2) 藤正 巖 他：負荷サーモグラムの時系列分析による病態生理機能画像への変換手法, *Biomedical Thermology* 8 (1) : 42-47, 1988
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- 7) 永江 學 : , :pp45-50

II

1.

1

1,3)

1

1. , ,
- 2.
- 3.**
- 4.
- 5.
- 6.

(1)

- 1) (造影) 2) 3) 4)
- 5) 6) 7) 8)
- 9) 10) (,) 11) C T
- 12) MRI . DSA(digital subtraction angiography)

(造影劑)

가

가

가 2

1

1)

2)

가 가

3)

4)

5)

6)

7)

8)

(2) 가 2)

1) 가

2

, (重症)

2

1.

(1) (CAO)

(5)

1) (ASO)

(6) , (癩)

2) (, , 1~6)

(TAO, Burger's disease)

2.

(2)

(1)

1) -

(2) ,

(3)

3.

1)

(1)

2) (膝窩) (補足)

(2)

3) (膝窩)

(4)

1)

2) Bechterew' Disease.

3) 가

2)

2

가

.(5.)

3)

2

가

4)

가

2

가) ()) ()
 ()) ()
) (虛血肢))
) 가
 가 3).
 “ ” “ ”

(3)

가 , 가 가
 가 .
 1) / 가
 (殿部)
 , 가 가
 3). ,
 2) 3 가 2).
 3

1.	2.
(1) , , , ,	(1) , ,
(2) (發汗) ,	(2) , ,
(3) , , ,	(3) , , ,

(4)

1) (ASO)

가

1~2 °C

가

2) (Burger's disease , TAO)

가

가

가

ASO

가

3) ,

2

4

(膠原病),
(汎發

性)

(膠原病)

가

가

thermal defet

가

1

4

1. ()

4.

2. ,

,

(紫斑病)

5.

, ,

6.

, Burger's disease

3. ,

4)

2 가 . 5 “P” pulselessness(), pain()
), pallor (,), paresthesia (,), paralysis()
 . 異常

가 가 .

subtraction

가 .

5) /

6) /

가 , .

(5)

/ 가 (1) 0.5 °C (2)
 5 가 .
 ,

(1)

, (2)

()						
	20	25	30	35	40	
	27.9	30.5	33.4	35.1	36.3	
	25.8	28.9	32.7	35.4	36.4	
	21.7	27.1	31.1	35.6	37.0	

1) (ASO)

(Criteria)

가) 가 .) 가 .) .)
 가 .) 가 .)

- (1)
- (2)
- (3)
- (4)
- (5)

2) (TAO)

(Criteria)

가) 가) 가)
 가))
 .)

- (1) , (2) , (3)

3) ,

(Criteria)

가) 가) 가) 가) 가)
 가))
 .)

- (1) (膠原病) (2) (3) (5)

(6)

가

1)

性)

가

(沮血
가

가

2)

/

가

가

3)

가

가

4)

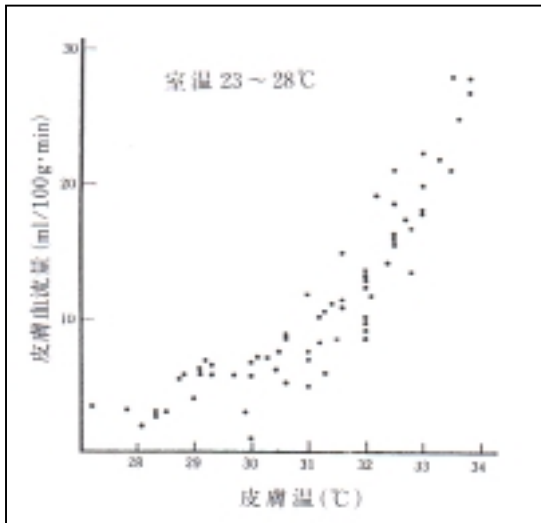
3

3

6

가

1)



1)

31°C

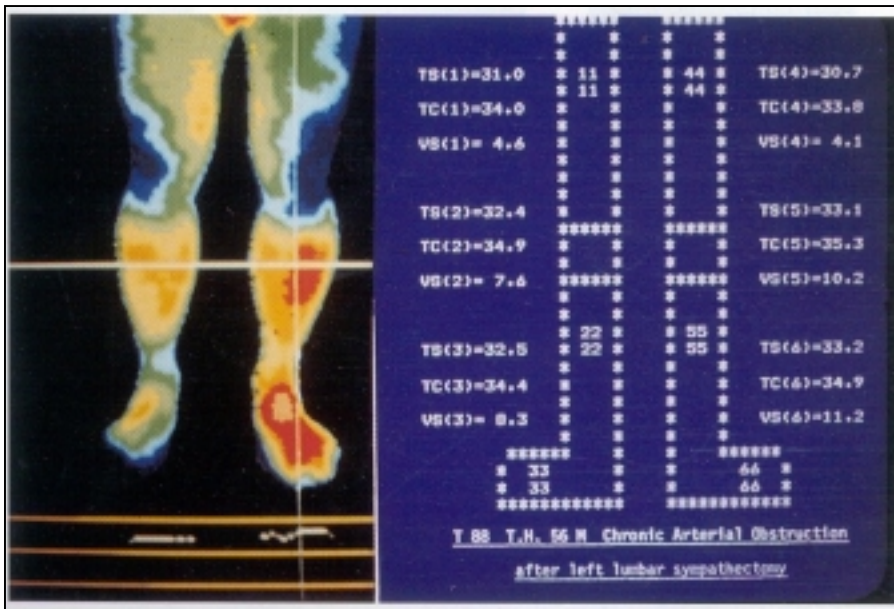
31

가

가 31

가

80%



(2)

4.6ml/100g/min.

(Routine screening

test)

- 1) 三島好雄 編：血管外科ハンドブック，南江堂，東京，1981
- 2) 中山昭雄 編：温熱生理学，理工学社，東京，1981
- 3) J. Juergens, J. Spittell, J. Fairbairn(Editor) : Peripheral Vascular Diseases, Saunders, Philadelphia, 1980

2.

(1)

1990 The American Academy of Neurology Therapeutics and Technology Assessment Subcommittee

1)

가
가

가 , 가

2)

(1) (2)
(3) (entrapment neuropathy) (4) ,

가

(理想的)

가

가 가

若宮¹⁾

(2)

가

가

()

, 若宮²⁾가

가

1
4,5



(1)

가

(control value of temperature)

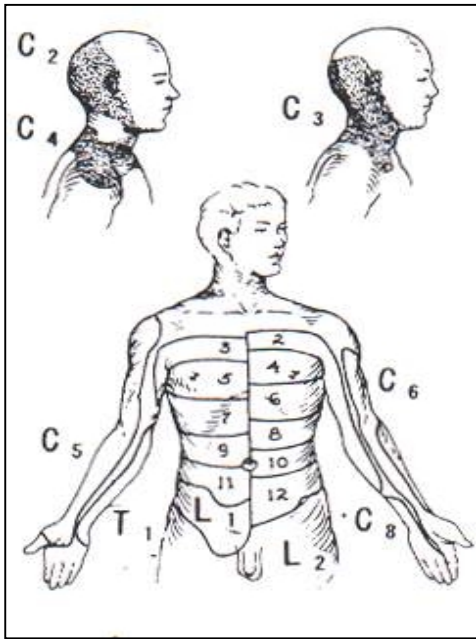
3))⁷⁾, 4))⁸⁾(가 5)6), (가 가 14) 9) Keegan 4 Foerster⁷⁾ 가 5)

가
가

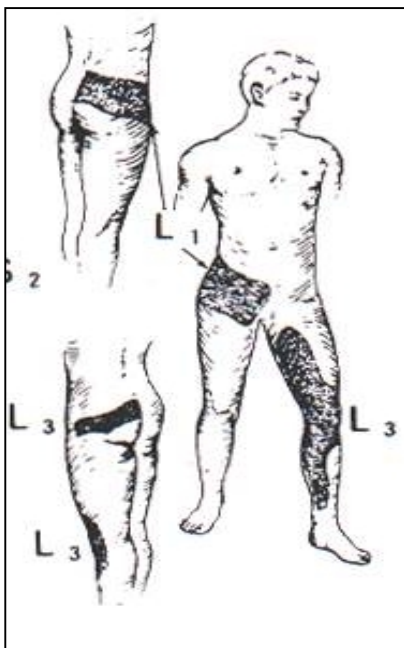
가

2

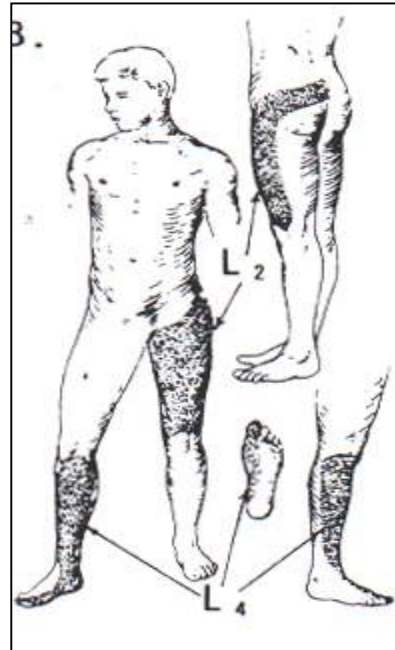
A. (根性)
(())



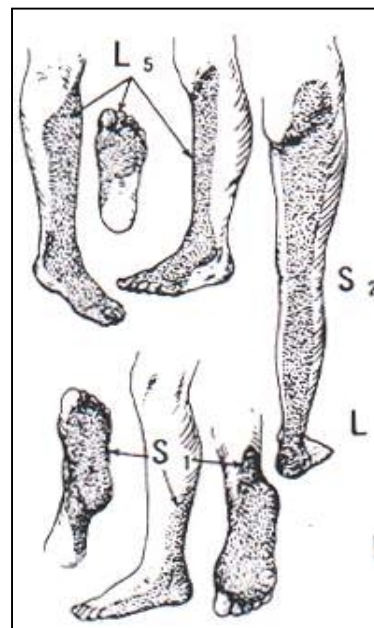
((.))



(Foerster)⁶⁾
((Lumbar))



((.))



B.

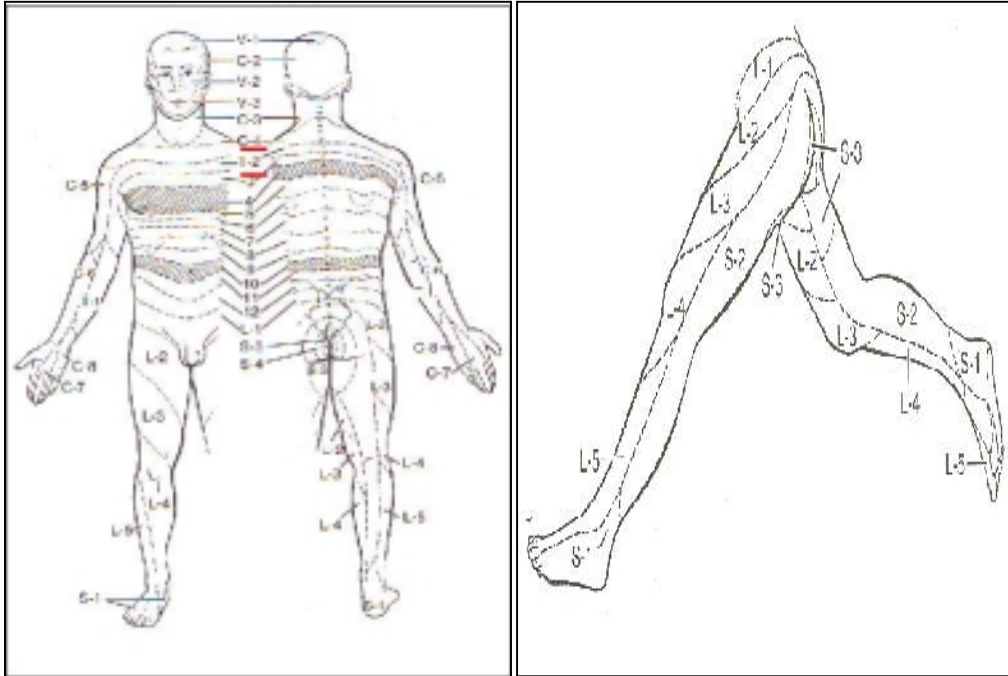
(根性)

(分節性)

10)

4

2



가 8 1 2

3 2 3 (尾骨)

20 25 (後)

根) 5 (節前纖維)

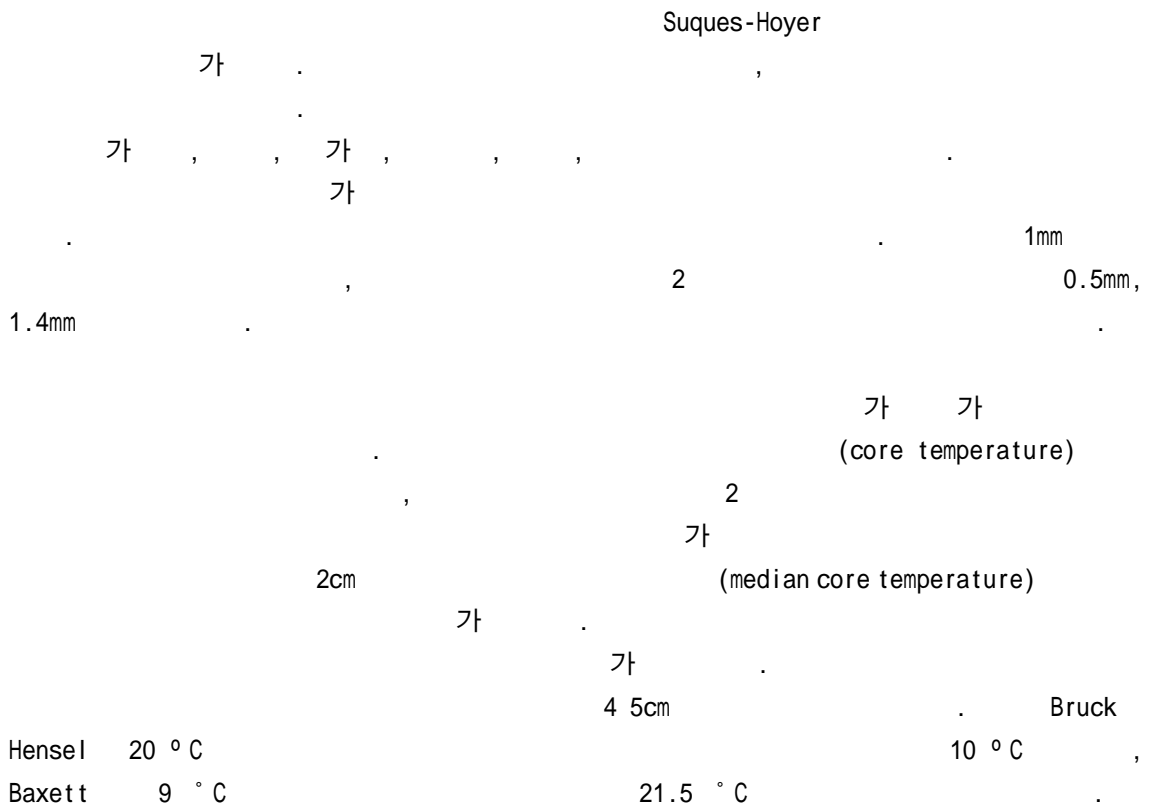
維) (節後纖維)

(alpha -)

(Folkow).

(beta)

(sweat) bradkinin



(3)

11)13)

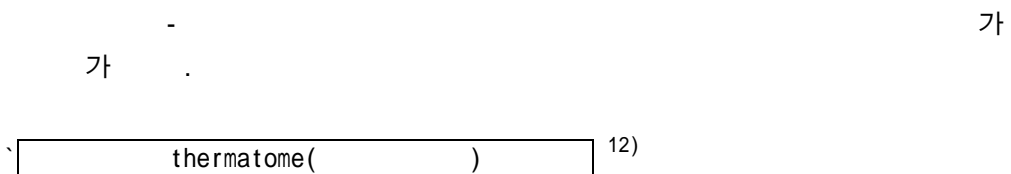


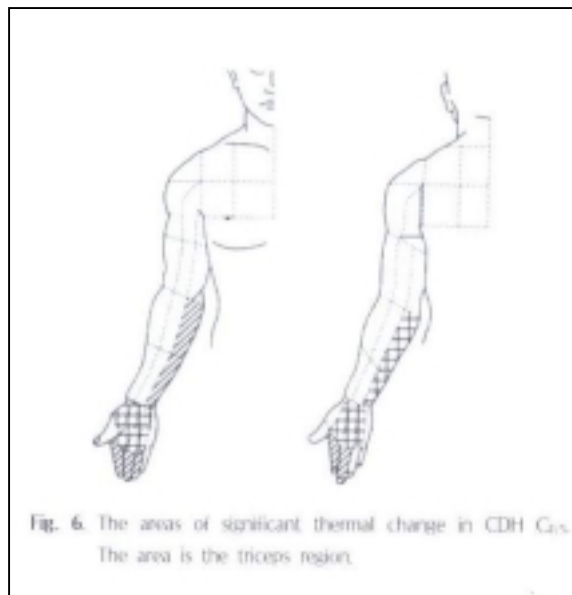
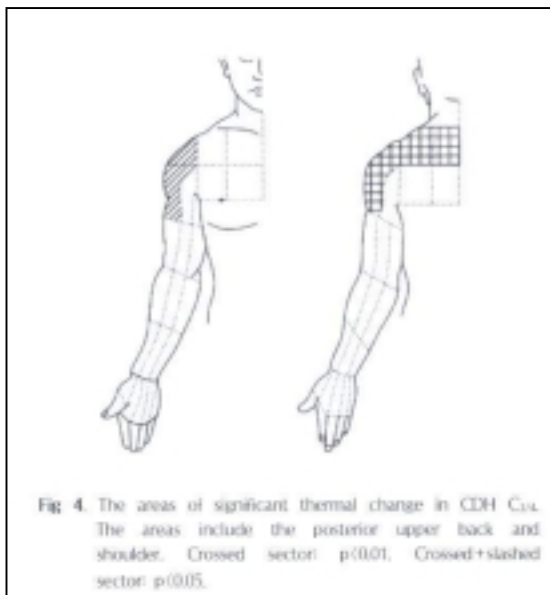
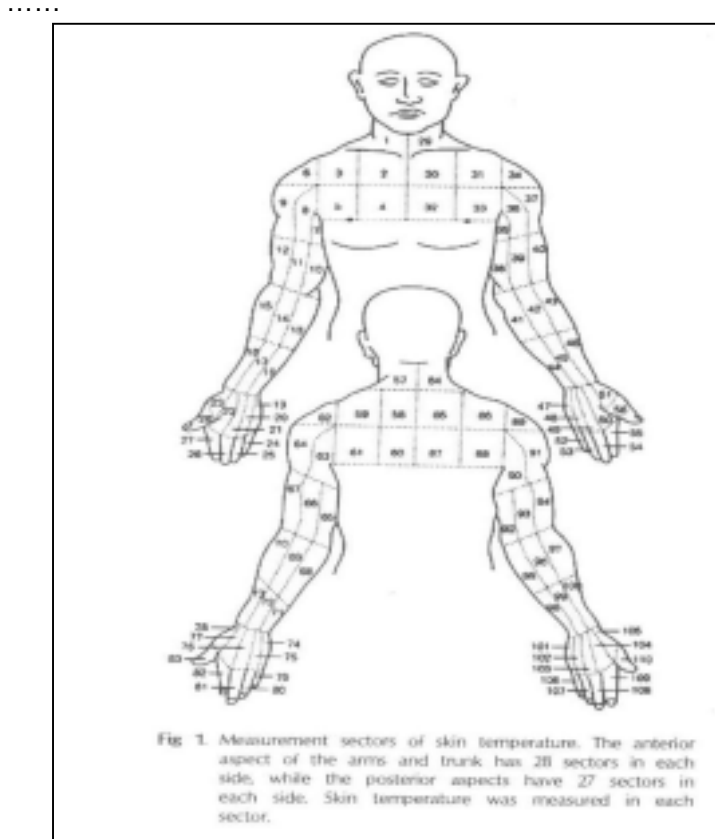
Figure 1.

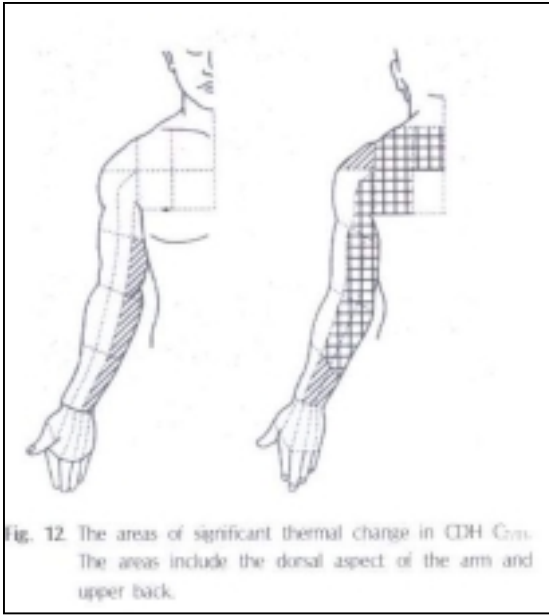
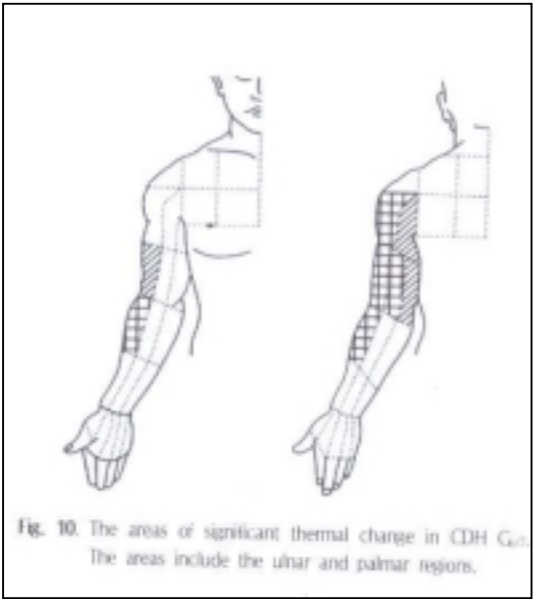
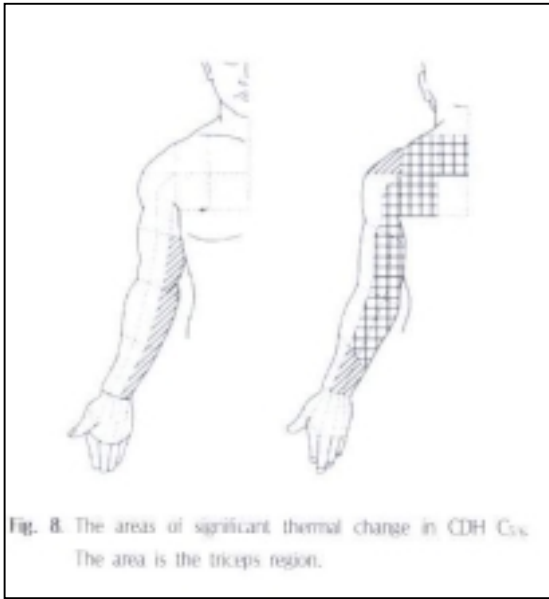
28

27

- Figure 4 . CDH 3/4 thermal change area ,
- Figure 6 . CDH 4/5 thermal change area
- Figure 8. CDH 5/6 thermal change area
- Figure 10. CDH 6/7 thermal change area

Figure 12. CDH 7/T1 thermal change area

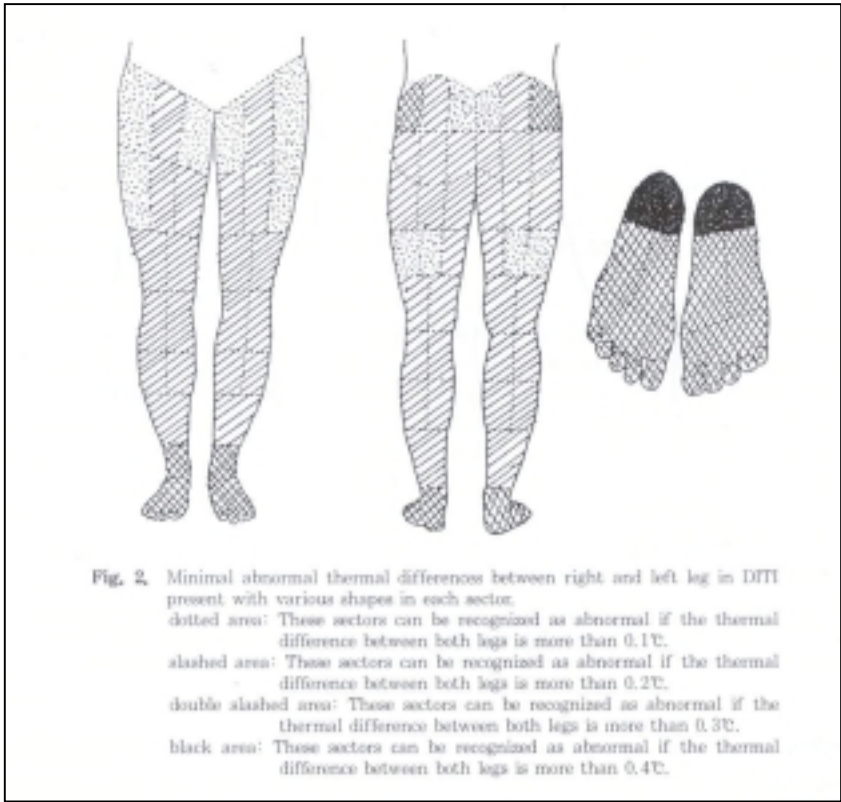
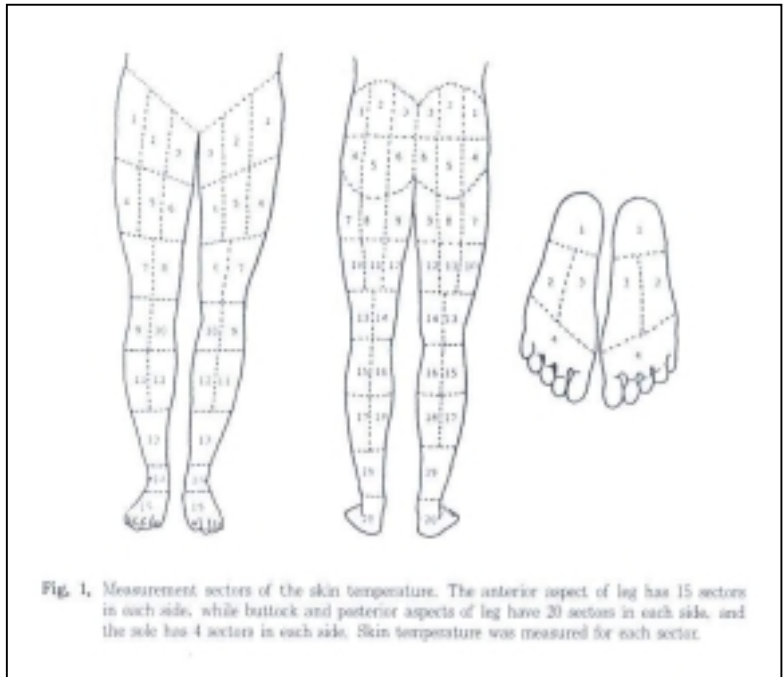


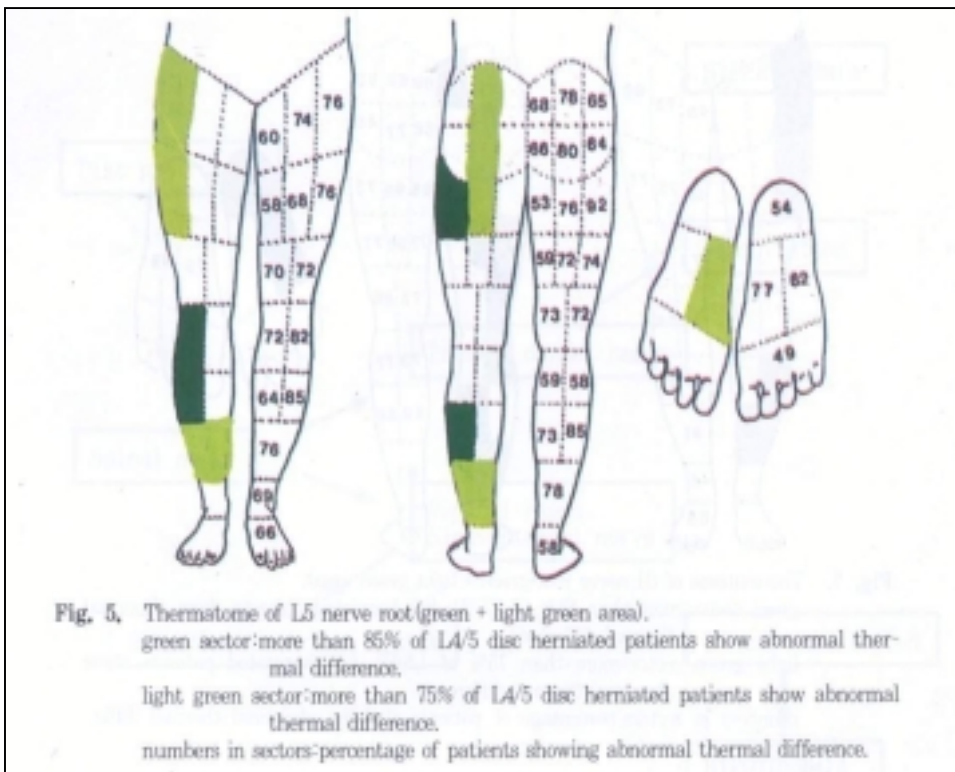
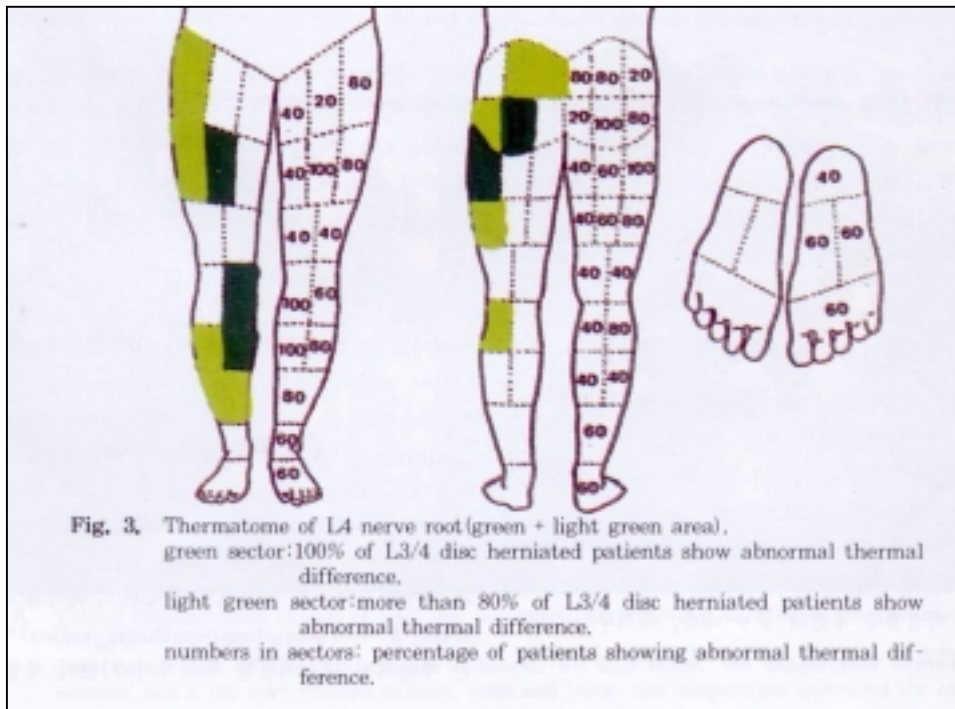


- thermatome() 11)

Fig1. 15 , 20 4

Fig2.
--Dotted area : 0.1 °C, Slashed area : 0.2 °C , Double slashed area : 0.3 °C
Blacked area : 0.4 °C





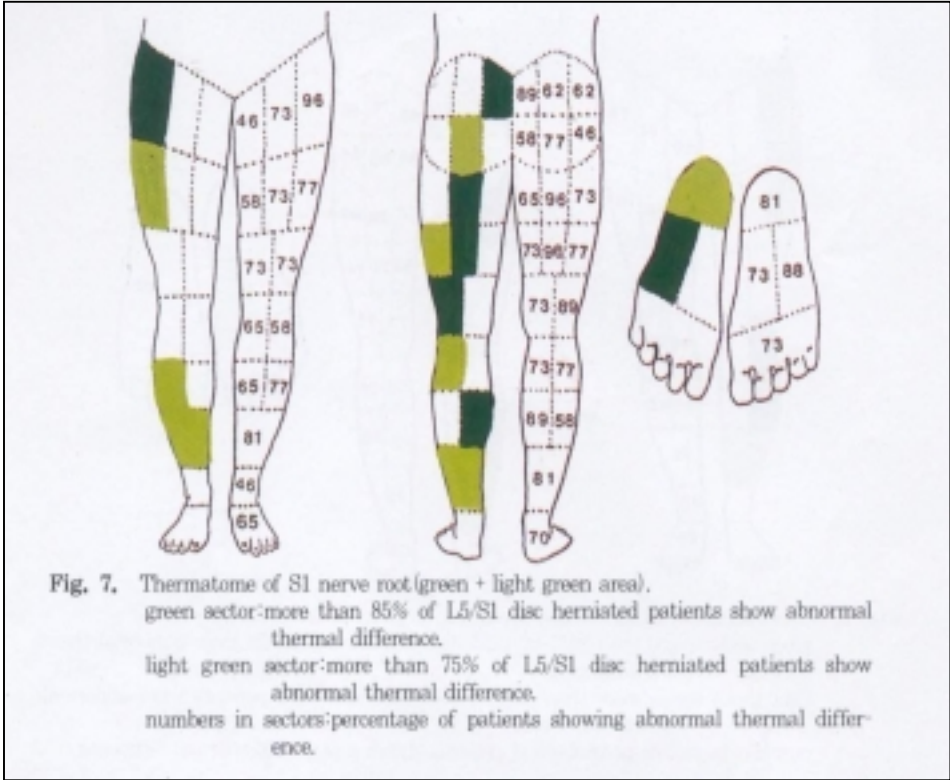


Figure 3, 5, 7 L3/4, 4/5, 5/S1 thermatome

/

75% 가 /

11)

11)

(thermatome) (sensory dermatome)⁹⁾

(sympathetic dermatome)¹⁴⁾

dermatome

13)

- 1) 若宮純司, 納光 弘, 井形昭弘 : 今日のサーモグラフィの意義と限界, 日本臨床 50 : 729-734, 1992
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- 5) 田崎義昭, 斎藤佳雄 : 第 5 章感覚の診かた・第11章感覚障害の診かた・ベッドサイドの神経の診かた, 南山堂 : 1-470, 1994
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- 8) 平沢 興, 岡本道雄 : 2. 神経系, 解剖学, 金原出版 : 185-538, 1982
- 9) Keegan JJ, Garrett FD : The segmental distribution of the cutaneous nerves in the limbs of man. Anat Rec . 1948;102:403-412.
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- 11) Young Soo Kim,M.D., Hyung Shik Shin, M.D. : Thermatome of the Lumbosacral Nerve Roots : 最新醫學 Vol 37.1994; 29-36.
- 12) Richter C.P., Woodruff b.G. : Lumbar sympathetic dermatomes in man determined by the electrical skin resistance method, J. Neurophysiol.1945; 8 : 323-328.
- 13) Zhang HY, Kim YS, Cho YE:Thermatomal Changes in Cervical Disc Herniations.J of Korean Medical Thermology.2001;16-28.
- 14) Richter C.P., Woodruff B.G. : Lumbar sympathetic dermatomes in man determined by the electrical skin resistance method. J Neurophysiology. 1945; 8:319-326.
- 15) Richter CT, Woodruff BG : Lumbar sympathetic dermatomes in man determined by the electric skin resistance method. J Neurophysiology. 1945; 8:319-326.

3. (脊髓)

가 1)2)
3)5)

(1)

4)

/

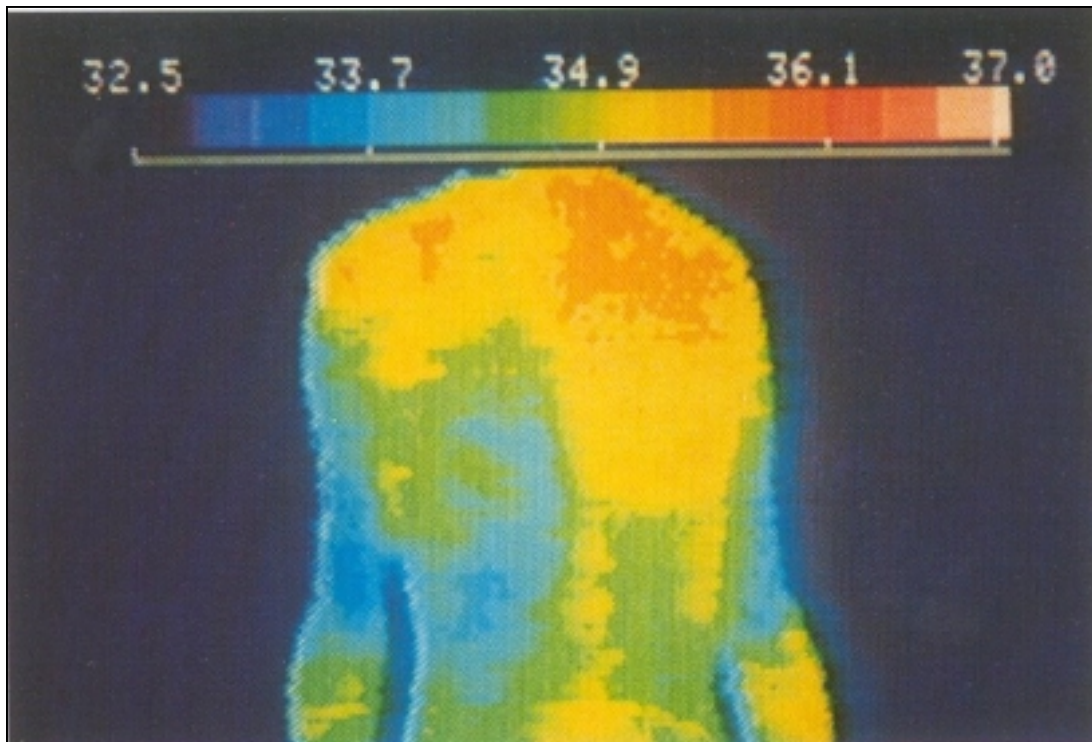
가 가

가 0.3

異常

1. (脊髓)

(背部)



(1).

가

/ 가

1)

1/3

1

3-4

(矩形)

ROI(Region of interest,)

ROI

1 3-4 ROI
가 heat stripe() (가 가
) () 가, heat flare)
(midline heat continuity on the back) 5)
/ 가 가

2) (背部温) 6)

가 7)8)
가 1/3
ROI 1 3-4
(頭髮) / (眼窩) (眉毛)
5-10mm ROI
1 , , / ()

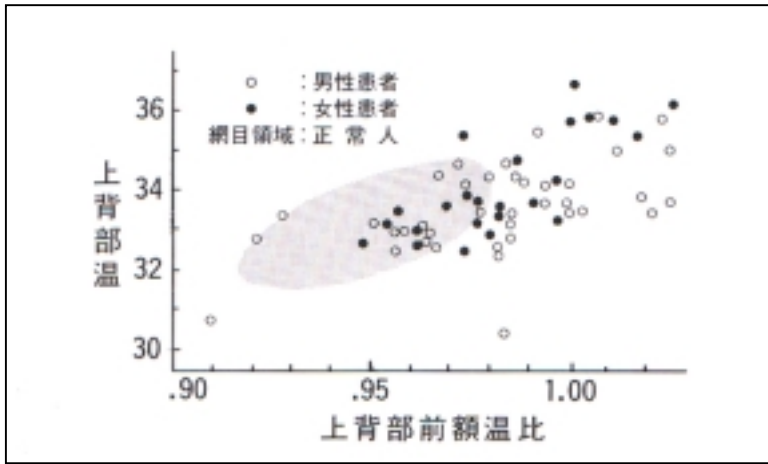
	(°C)				
				/	/
(n=67)	34.2 ± 0.5	32.8 ± 0.6	32.4 ± 0.7	0.959 ± 0.011	0.944 ± 0.013
(n=31)	34.3 ± 0.4	32.5 ± 0.7	31.9 ± 0.8	0.947 ± 0.016	0.931 ± 0.01
(n=98)	34.3 ± 0.4	32.7 ± 0.7	32.2 ± 0.7	0.955 ± 0.014	0.940 ± 0.016

가
0.955 ± 0.014, 0.940 ± 0.016 (1).
3,4
/
가 . /
(2).
sensitivity / 69.8%, /
54.0%, 44.4% 3가
가 , sensitivity 84.1%

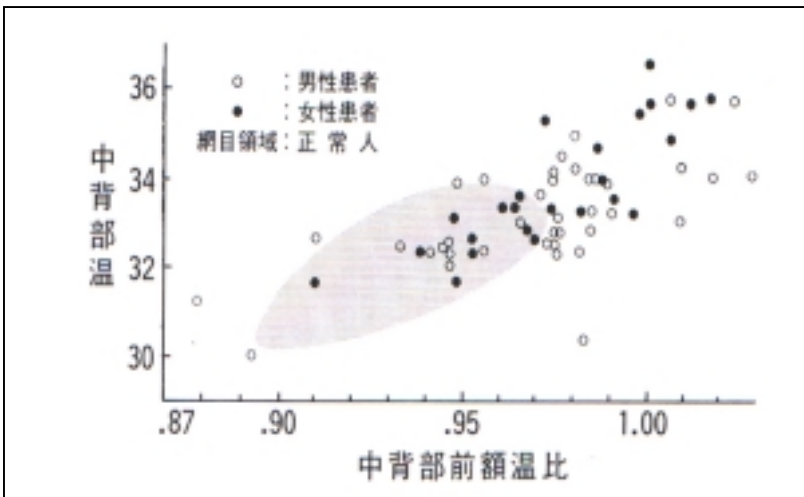
(2)

(intermediolateral nucleus) 3)

가 가 가 T1~L2-3
 가 ()
 가 가
 가 가 46).



(2) /



(3) /

- 2
 1. U/F: / , M/F: /
 2.

(U:upper back, M:middle back, F:fore head)

	U/F(-) M/F(-)	U/F(-) M/F(+)	U/F(+) M/F(-)	U/F(+) M/F(+)	
-)	10 (3)(0)(6)(1)	2 (3)(0)(6)(1)	0	8 (3)(0)(6)(1)	20
-)	0	0	0	9	9
+) (-)	5 (1)(2)(1)(1)	0	0	10 (2)(2)(5)(1)	15
+) (-)	4 (1)(1)(1)(1)	1 (0)(0)(1)(0)	0	14 (5)(3)(3)(3)	19
	19	3	0	41	63

가 (視床)

T1~L2-3

9)

2

3

10

2

, 1

T10-12

T1~L2-3

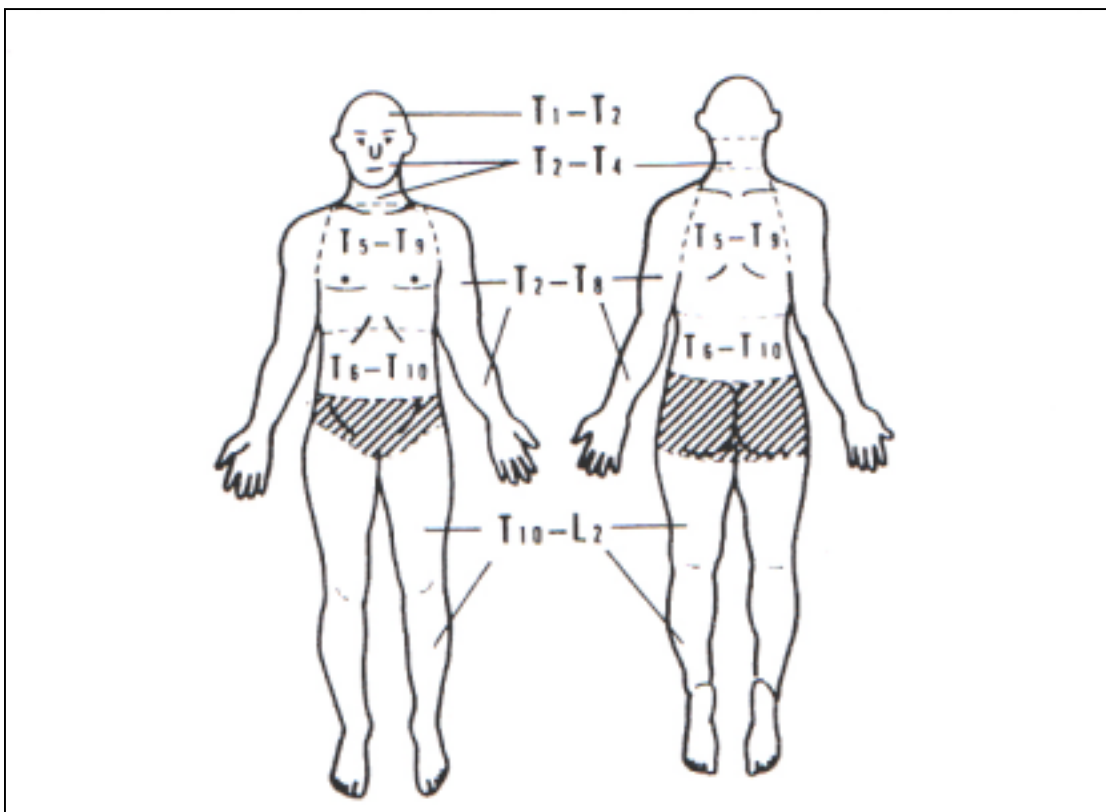
, 3

3

()

	(髓節)	
	C8/T1-T3/T4 T1-T4 T1-T3 T2-T4 T2-T5	Johanson Bonica Kure Brodal McDowall

	T1-T5 T2-T8 T3-T6 T4-T7	McDowall Bonica, White, Johanson Brodal Kure
	T6-T10 T7-T9 T5-T9 T7-L3	Johanson Kure McDowall McDowall
	T10-L2 T12-L3	Bonica, brodal, Kure McDowall, Johanson



(4) 3, MRI

MRI
5

가

가

(3)

가?

MRI

가

가 3)

/ (全額背部) (2) /

MRI

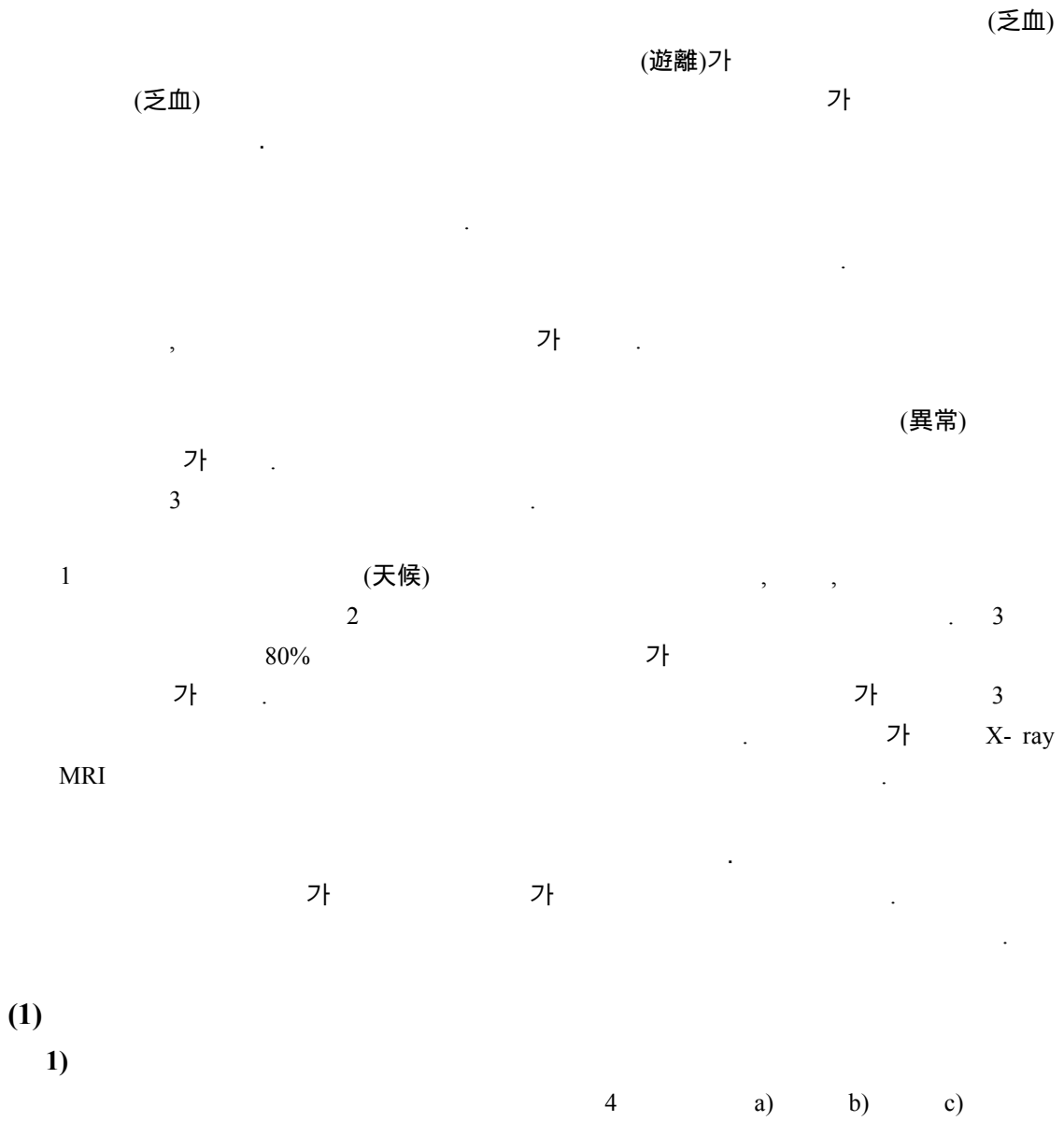
가

MRI

가

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- 9) Brodal A : Neurological anatomy in relation to clinical medicine. Oxford Univ Press, New York, 1969

4.



d)

(遊離) substance P가
bradykinin, histamine neuropeptides

가

substance P

1)

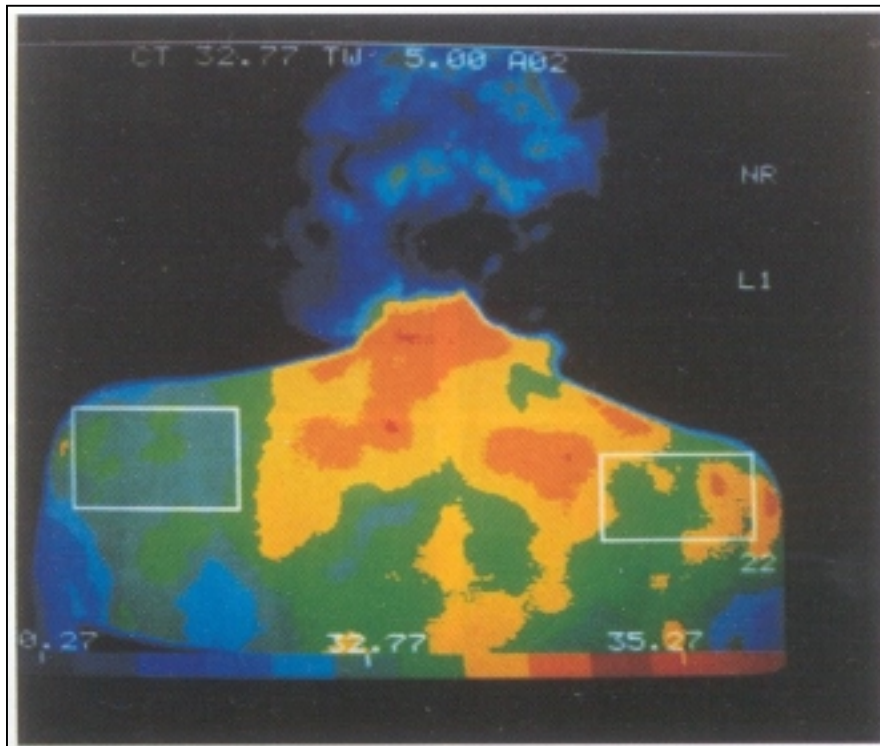
2)

1980 Wexler

2) 가

(異常)
가

1. 37 , (左肩甲部痛)
(頸部)



26

(心因性)

가

5

21

3)

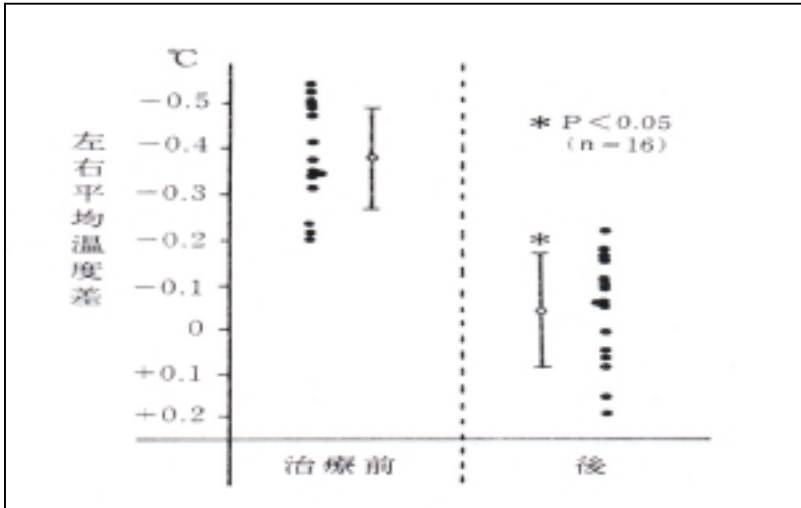
16

(2).

1.

(筋不動) (

)



2

(Pain score 2)

/

가

/

0.2

3)

가

가

가

가

L5, S1

가

4)5) 가

가

가

5)6)

()

가

7)

가

가

가

4)

(無發疹型) (皮膚) (皮膚)

(PHN)

(乏血) PHN Varicella-Zoster 가 PHN 가

(癍痕) PHN PHN

PHN PHN 가

(亞急性) PHN 가 (iontophoresis)

8) PHN 가

(reflex sympathetic dystrophy, RSD)

가 가

5)

가

가

X-ray, CT, MRI

가

(心因性)

가)

가 / 가

가

)

가

가

가

가

가

)

(心因性)

(心因性)

(鬱病)

(鬱)

(妄想)

가

)

가

가

(가

)

(異常)

가

(異常)

6)

(肩關節 周圍炎:

50%

)

가

가

(凍結肩)

delto-pectoral portion

가

가

(2)

/

/

가

4

, 가 ,

4

/

9)

(屈側),

/ 가 0.3

thermal-pattern

0.2

9)

- 1) 寺田美恵, 真崎容子, 矢部雅哉 他: サブスタンス P に対するリドカインの拮抗作用について, *Pain Research* 5: 17-22, 1990
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5.

가 , 2) 가 가 1) , 3) , 4) 가 가 , 5) 1)2)

(1)

1)2)

1 -

*

(股) ... (膝) ... (肩) ... (50) ...

*

(腰椎) ... (頸椎) ... ()

*

... ()

*

*

(2)

가 가 가

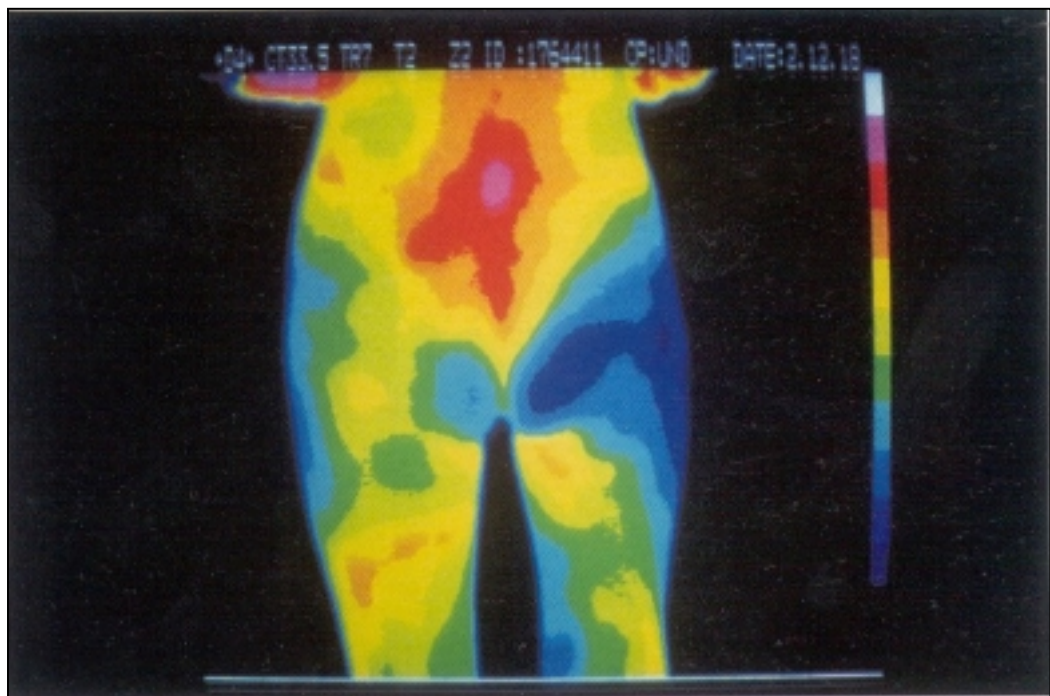
가

가 ,

가
 / 가
 (面) (点) , (矩形)

가
 (3) 가
 1)2)

1)
 가
 3~5)
 가



(1). (股關節)

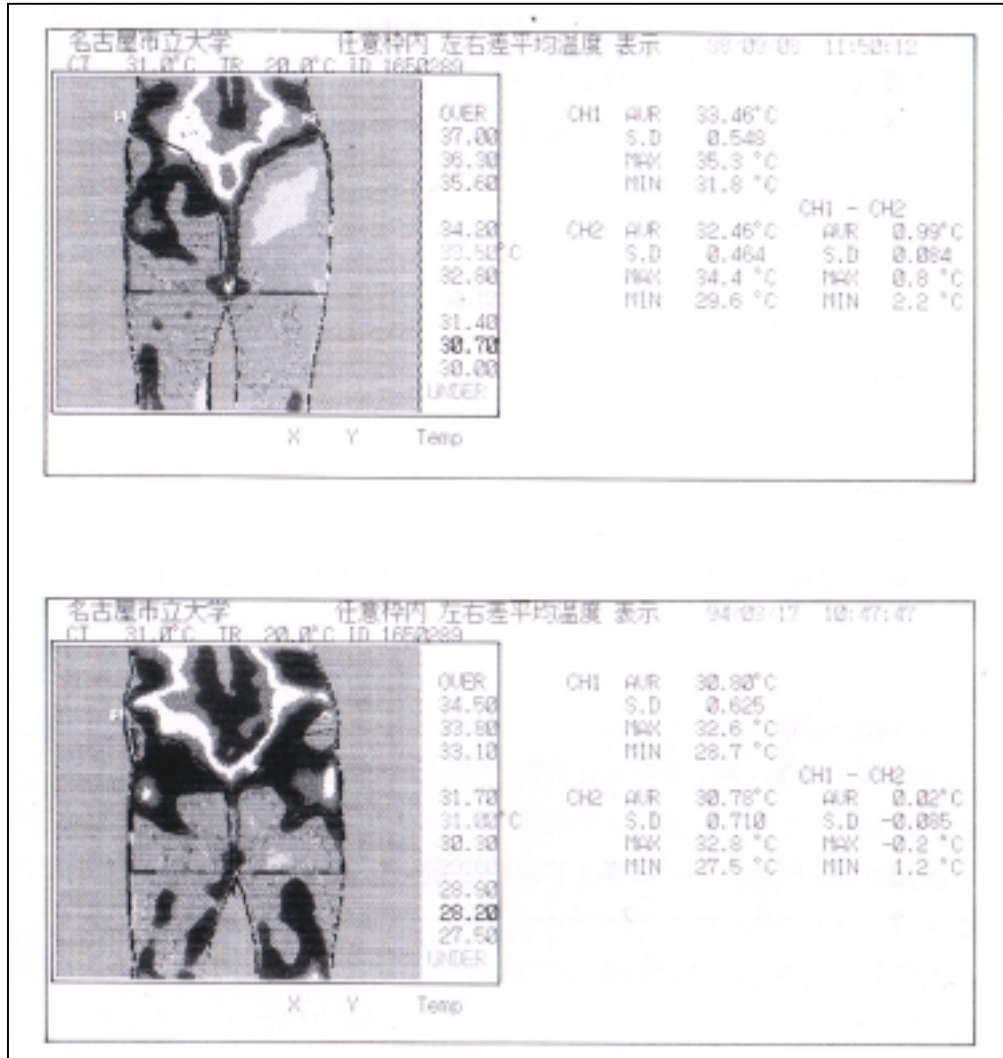
()

(1)

가
(外轉筋)

가

가



2.

: , : 5 4

/ 2(上)

() 0.99 가

가 (100) 50

가

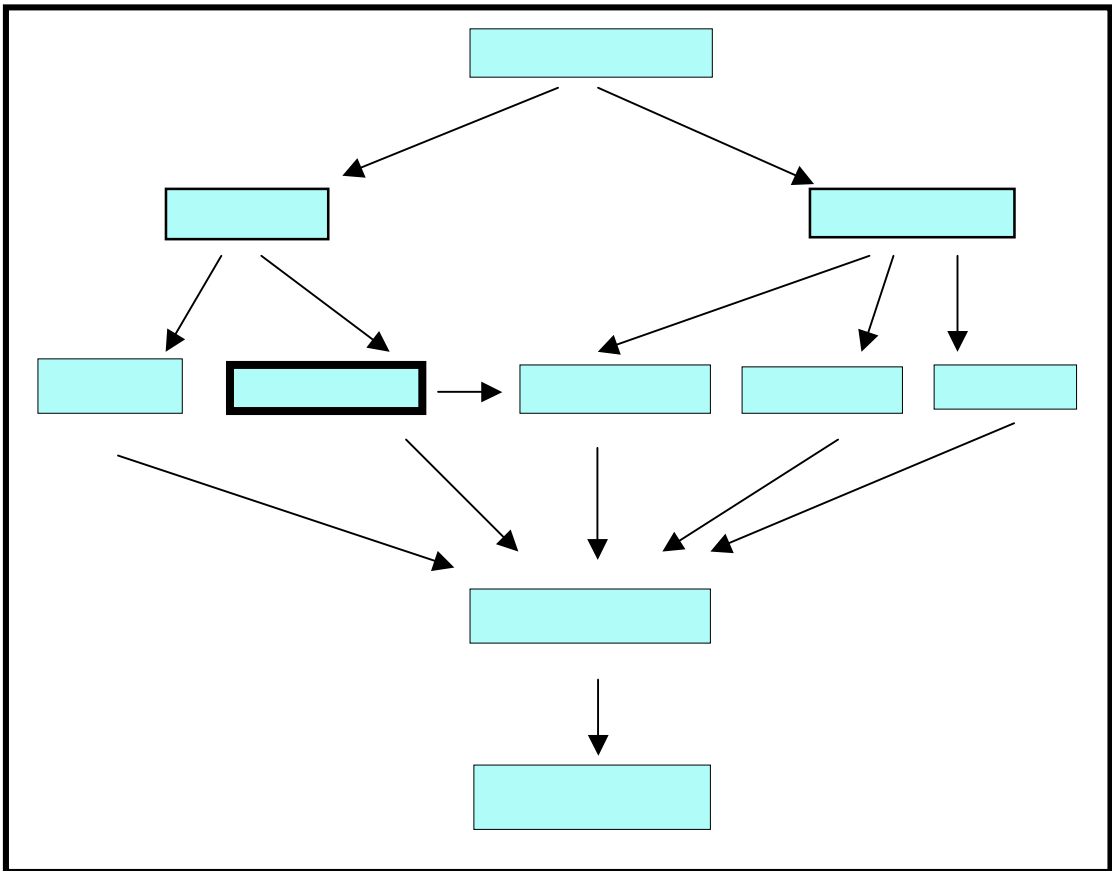
(2).

가

가

2()

가
 / 가 2() 5 4 / 가 0.02
 가 44 , 2() 100
 가 가
 (3).



(3)

thermographic index (T1) Collins Ring, Engel 가 6~8)
 가
 (穿刺排液)

가

가

()

가 /

가

2)

(腰椎) (椎間板)

가 , Keegan

(dermatome) 가

MRI

(thermatome)

(vascular thermatome)

가 / 가

가 가

(間歇性跛行) (脊柱管狹窄症) 가

가

(頸椎後從韌帶骨化症)

1, 2 가 가

1, 2 가 가 가 ,

가 가

(鬱血性)

가

(가)

가

3)

가 가

가 가

가

가

0.43

가

/

19

가

(上腕神經層)

가

가

가

0.41

0.53

가

가

가

가

9)

4) -

가

가

X

5) (Myofascial pain syndrome)

가 5-10 cm
 가
 11), ,
 Fischer¹⁰⁾ 64%, 11) 74%,
 12) 81.8% . 12) lidocaine
 lidocaine 가
 lidocaine dry needling 11)
 가
 가

(4)

가 , 가 가 ,
 가 가 가
 1) 가 가
 2) , , (體幹) / /
 3) 가 , 가 5 가
 4) 가
 5) / 가 /
 6) 가
 7)
 1) (異常) , 가

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- 11) , , : Trigger point . 1991; 15: 527-533.
- 12) , : 가. . 1997; 21(3): 500-510.

6.

가 2 , 異常 (多糖), , ,

(1)

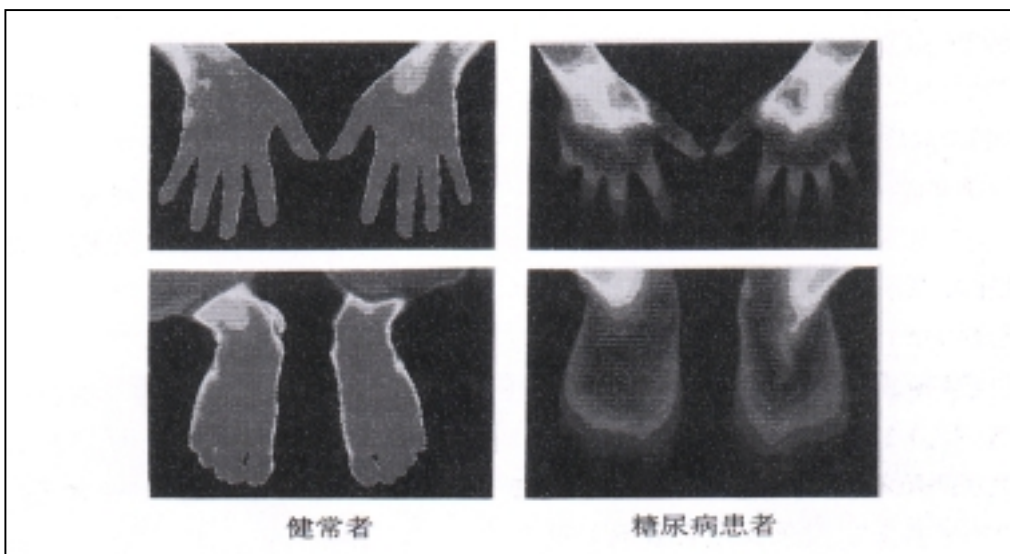
insulin , insulin 가 , 가 가 가 (壞疽) 가 가

1).

(2)

1)

가 , (가) 가 / 가 (가) 가 / 가 3)



(1)

3)

가 가 가

II.III.IV

1

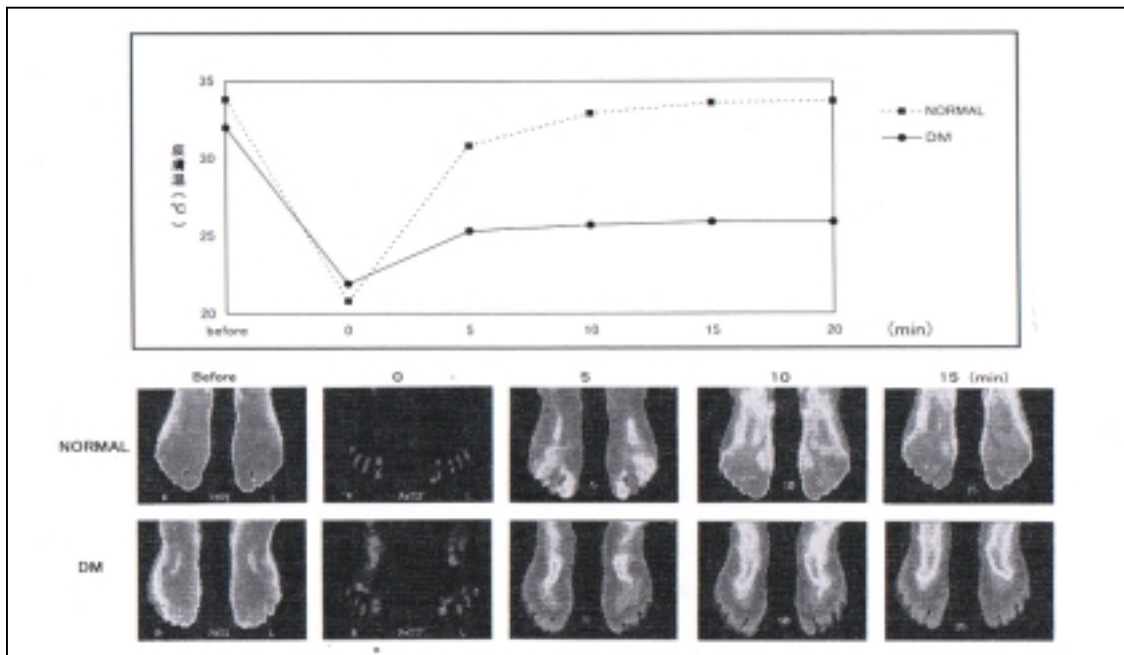
(가 , 가) 가

1

1

(mean ± SD) ()

	()		()			
	32.4 ± 1.3	33.0 ± 1.2	32.4 ± 1.3	33.0 ± 1.2	33.7 ± 1.7	33.3 ± 1.3
	3.24 ± 1.4	33.0 ± 1.3	32.4 ± 1.4	33.0 ± 1.3	33.7 ± 1.6	33.2 ± 1.2



(2)

가)

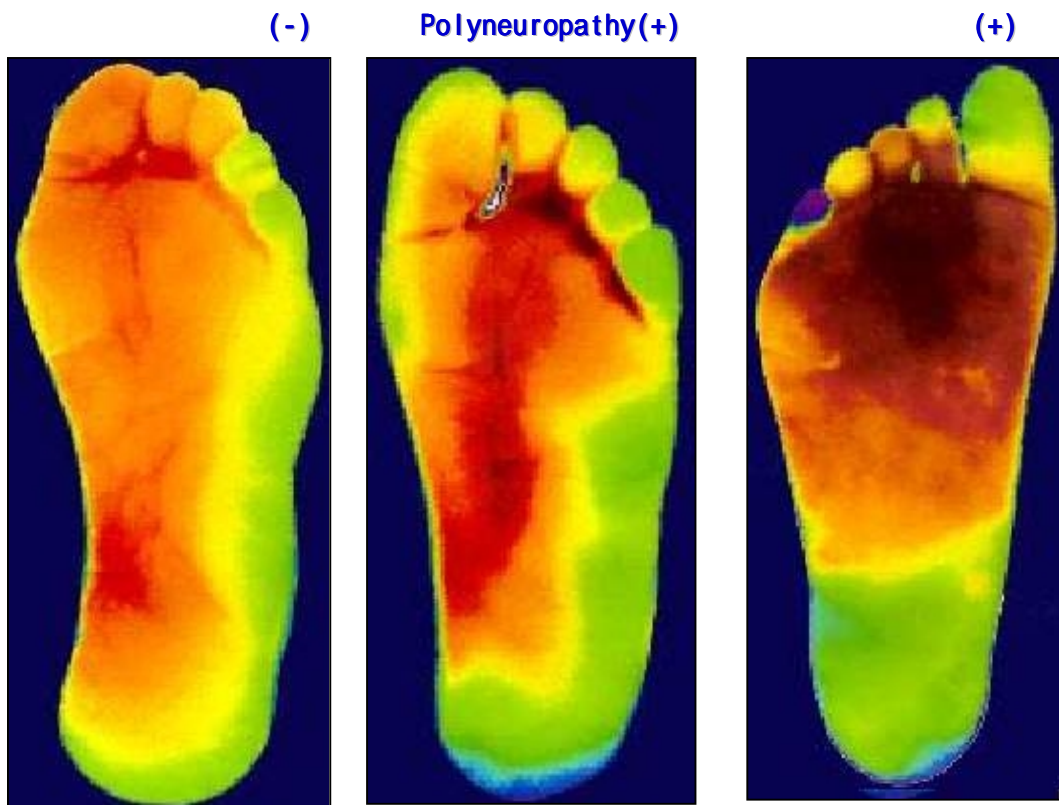
-
-
-
-

)

가

: great toe(GT), 5th toe(T5), heel(H), 3rd metatarsal head(MT3), lateral plantar arch(LP), medial plantar arch(MP)

)



2)

가

가

가

4)

2 10

1

3)

異常
(定性的)

가

$$t \quad (\%) = \frac{1}{-} \times 100$$

(2)⁵⁾.

가

가

가

(40~59)

(60~70)

6)

2

	(n=122) 47.9	(n=100) 53.8
5	85.7 +- 9.7	64.9 +- 21.9*
15	95.8	85.9
5	79.3 +- 14.2	52.7 +- 15.9*
15	98.0	67.1

(%) (mean +- SD) *p<0.01

122

3

5

15

50

15

5

3)

3)

4)7)

가

가

가

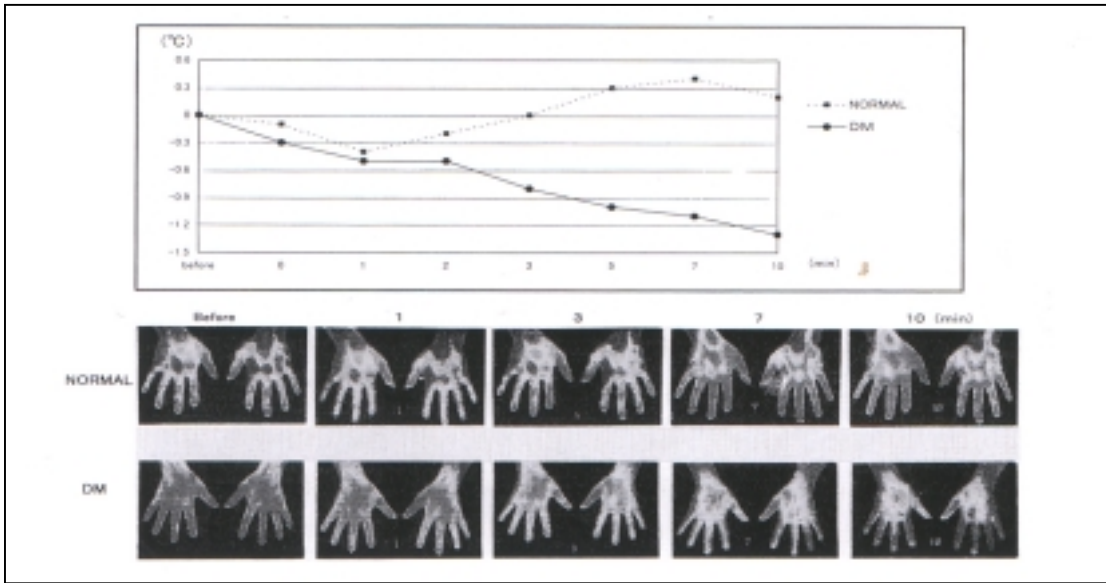
(3)

30

가

가

가



(3)

가

7).

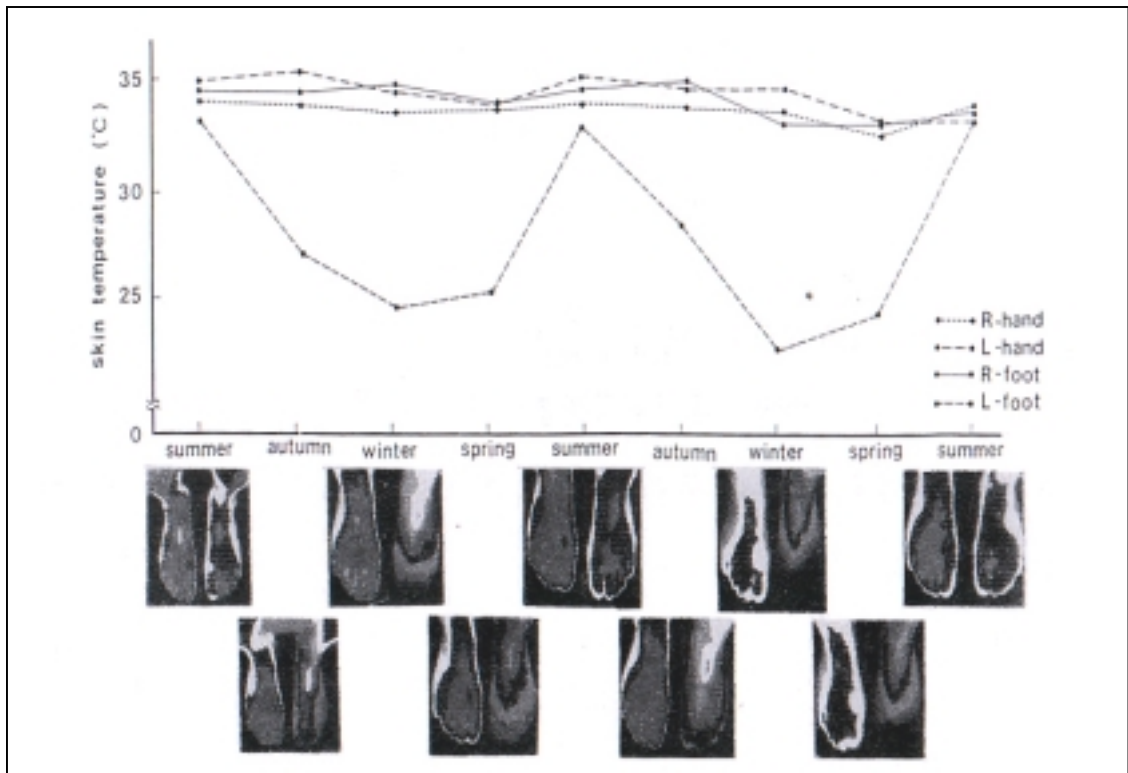
가

4)

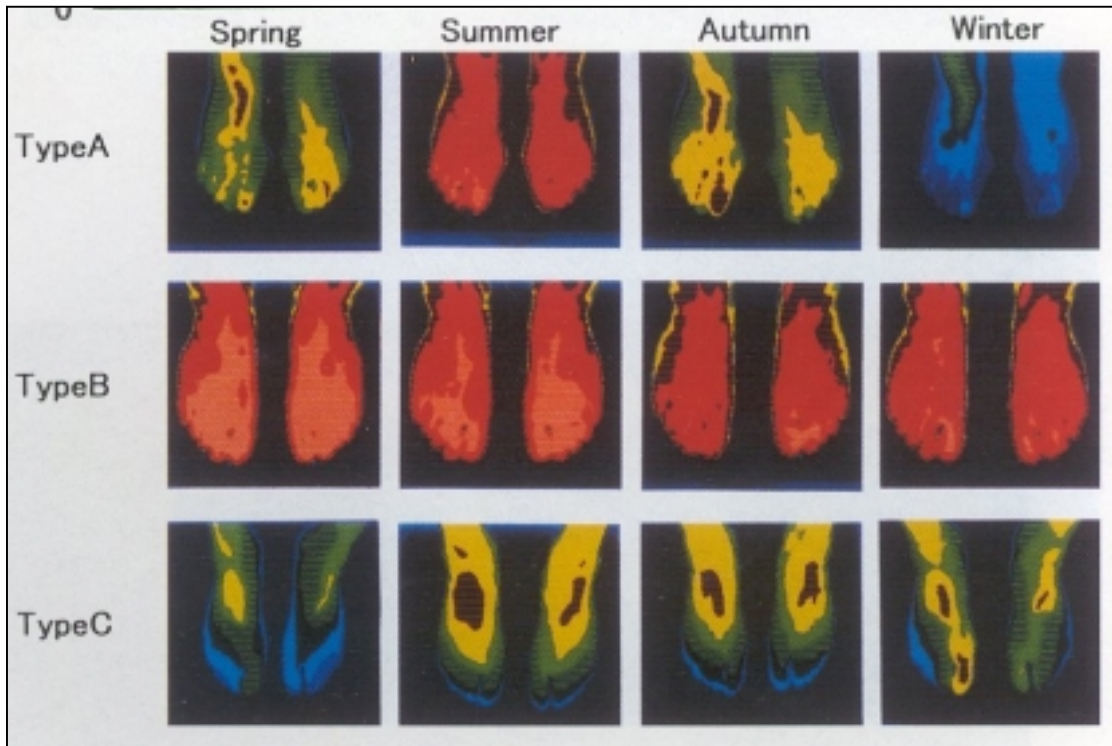
가

4

4)5)9)



(4)



(5).

3

(5).

5

Type A

5

32

Type B

5

32

Type C

가⁹⁾

2

가

가

가 . Type A

가

5) (壞疽)⁶⁾

가 (壞疽)

가

(壞疽)

a.

b.

가

c.

가

6)

6)

가

(, ,)

가

E1

(切斷)

腑

가

(總和)

가

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- 5) 松岡 瑛 他：臨床検査におけるサーモグラフィの現状と今後の課題 糖尿病・循環障害, *Biomedical Thermology* 14 : 154-161, 1994.
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- 9) 鹿野昌彦：各疾患における診断基準の提案, *Biomedical Thermology* 11 : 191-193, 1991.

7.

(1)

2000

1) 1956 Lawson²⁾

Lawson 가 가 가 가

가 Lawson Gaston³⁾ 가

가 가 가 가 3)

NO(nitric oxide)가 가

4)5)

가 8)9), 가¹⁰⁻¹²⁾ 가 6)7),

가 13)14) 가 X-

130 15)

89.6%

(2)

1)

248 (68%) Head¹⁰⁾ 68 (19%), 47 (13%) Jones¹¹⁾ 363

35 (35%), 65 (65%)¹⁵⁾

90.0%, 89.9%, 89.6%

2)

240
130 90.8% 16) 110
10.8% 가

3)

16)
16,17) Gautherie¹⁶⁾ 가
doubling time 가
가 doubling time 가가

4)

Head¹⁷⁾ 가 ferritin , DNA S-
Ki-67 (Proliferative-associated-antigen)
가 가

5)

Gautherie¹⁶⁾ Q
Q0-4 Q 1380 가 Jones¹¹⁾ ,
Isard¹⁸⁾ Q 가 가
가 가
19) 103 가 2cm 27
S-III 1 가 5 cm 17
S-I 1 가 S(Survival index)
Gautherie¹⁷⁾

6) (screening)

Hobbins20)

32 23% 68% 10% 89% , Amarlic

(3)

1)

가)

가

가

가

)

50~60%

가

가

24+- 1

18

가 20 가

가

가

가

)

10

가

2)

가)

가

가

skin to skin cross radiation
(下椽)

가

)

32

5

1

1

)

7),8).

(噴霧)

가

가

(4)

21).

가

(Th-1),

(Th-2),

(Th-3)

(1, 2,3)

1.

Th-1 ()

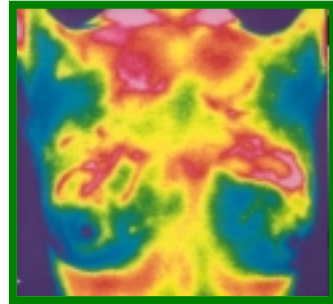
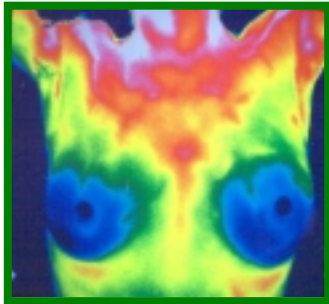
가

Th-2 ()

Th-3 ()

1 : Th-1 ()

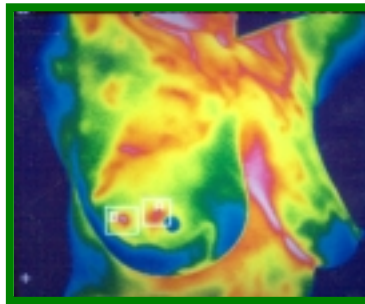
가



Th -1 (Normal) A vascular symmetry

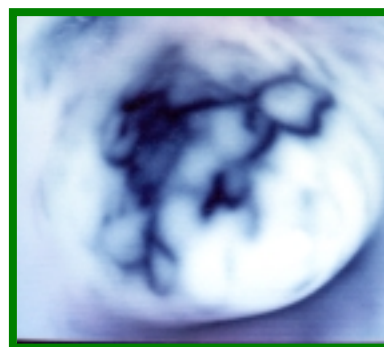
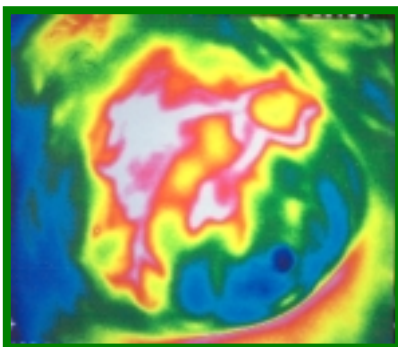
Th-1 (Normal) Vascular symmetry

2. Th-2 ()



Th-2 (Equivocal) : Localized heat abnormality only

3. Th-3 ()



Th-3 (Abnormal) : Localized heat & vascular abnormality

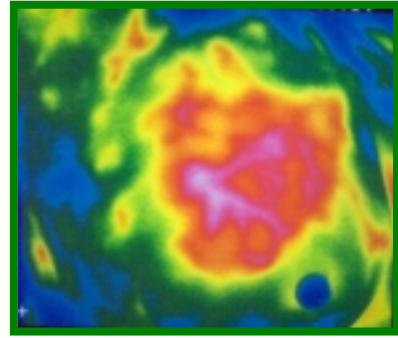
2)

45

3m

: 가)

가)



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8.

(varicocele)

(蔓狀靜脈叢, pampiniform plexus)
(90%)

(蛇行)

가
가

(逆位)가

가

subclinical varicocele

1)

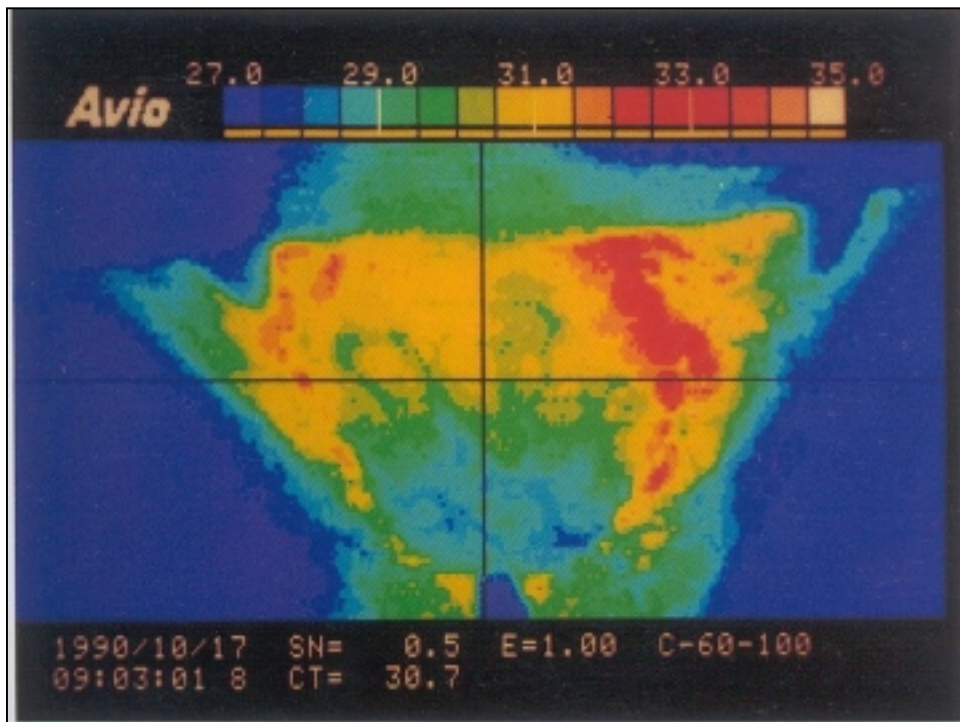
(1)

가 0.3

異常

(異常)

1. (精索) (靜脈瘤)(32),



(1). 가 2). 가 가 가

(2)

98.4%, 92.7% 2)
subclinical varicocele .

2) 3

- 1) Yamamoto M, Hibi H, Hirata Y, Miyake K, Ishigaki T : Effect of varicoelectomy on sperm parameters and pregnancy rate in patients with subclinical varicocele : A randomized retrospective controlled study J., Urol 1996; 155 : 1636-1638
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9.

1)~4)

(1)

- 1) 2) , 3) 4)
- 5) 6) 7)

(())

1)

tapering off

thermal amputation

(强皮症) 가 ¹⁾
(細動脈)

4)5)

2) (網狀 皮斑)

cutis marmorata teleangiectasia congenita (皮斑)

3)

- 1) () b) () c)
- 가 (瘰)

(造影) screening test 가

가

(造影)

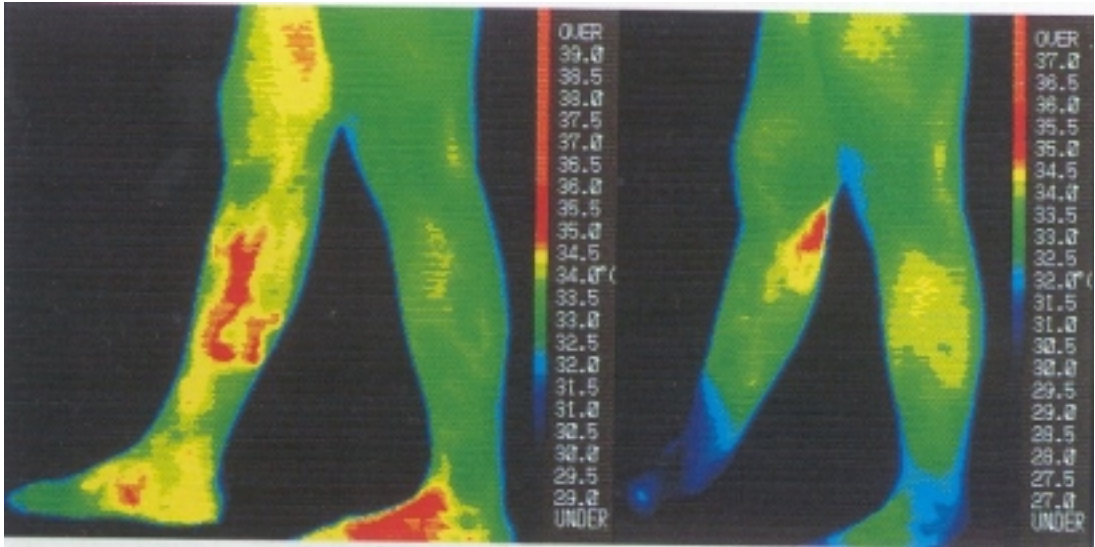
5)

4) (鬱滯)

1/3

, 가 가 가 가
가
整

가
 , 가 (鬱滯)
 1 , 가 (鬱滯)
 가



(1). 65 , (結果)

5) , 가
 가

2 3)
 6)

(病巢)가

7) 가
 / 가
 6 6) 가
 가 가 30 가 7)

) ,

10

가 가 2

가 .

(2)

, ,
 , (蕁麻) , (枇糠) , SLE
 , (紫斑)
 , ,
 (膿瘍),
 , Sweet

, , ,
 , ,

, , ,
 , , ,
 , , ,

2)

- 1) 三木吉治：サーモグラフィの臨床的応用，西日本皮膚 40：696-701，1168-1175，1176-1186，1978
- 2) 三木吉治，熊切正信，村野早苗 他：皮膚疾患系（膠原病，形成外科領域を含む）サーモグラフィ診断基準，Biomedical Thermology 12：154-157，1992
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- 5) SHIRABE, H., TAKAGI, K., KAWATSU, T., Evaluating of infrared thermographic diagnosis and ultrasound color doppler ultrasonography in patients with peripheral circulatory disturbance and skin ulcer. Biomed Thermo. 1995;15：163-165
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10.

, 가 , / , ,

가

가

(舌口腔底癌)

가

가 가
가

가 가 가
가

1~5)7)

< >

(1)

가

1)

(瘦)

2)

1

2

가 ,

3)

(2)

(穿通枝皮弁) , (遊離皮弁) ,
가 .

2

1)

thermal recovery

1)4)5)

thermal recovery

1 a)

(廣背筋)

(

)

thermal recovery

(廣

背筋)

(胸背)

(

).

가

(胸背)

(分枝)

(1b).

thermal recovery

4).

2)

(穿通枝)

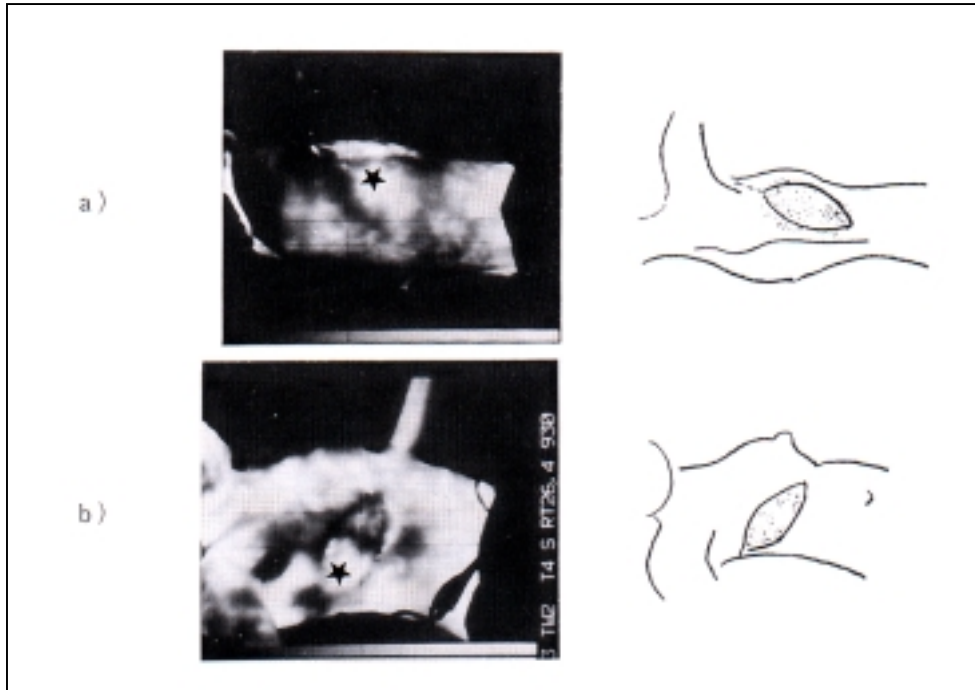
1~4)

(頭部)

(頸部)

(hot spot)

6)



(1).

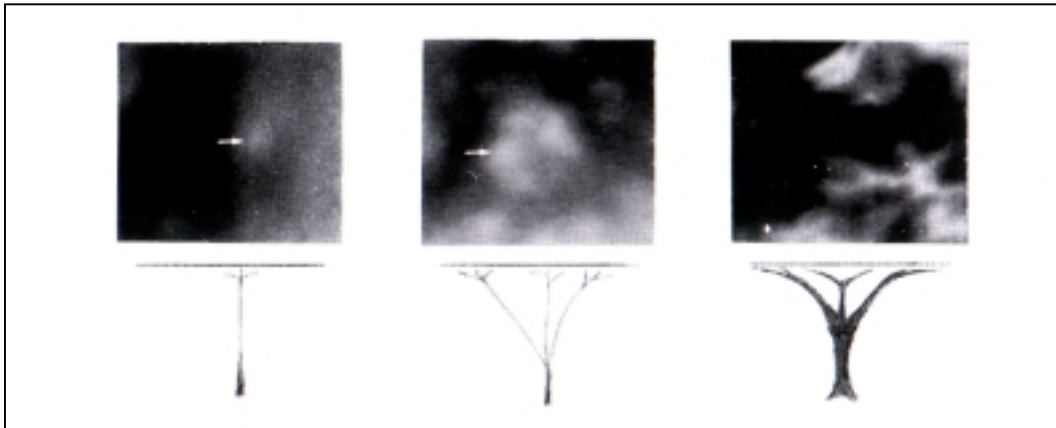
가) (廣背筋) (胸背) (),
)

(島狀皮弁, 腋 가) 0.5mm 가
 (遊離皮弁, 가)

(走行) 가 (2)⁷⁾.
 가 hop spot 가 가
 (type I). 가
 (Type II).
 가

(2. , Type III).

(3).
 Type III 가 Type I



Type I

Type II

Type III

(2).

가

(Type I).

가

(Type II).

가

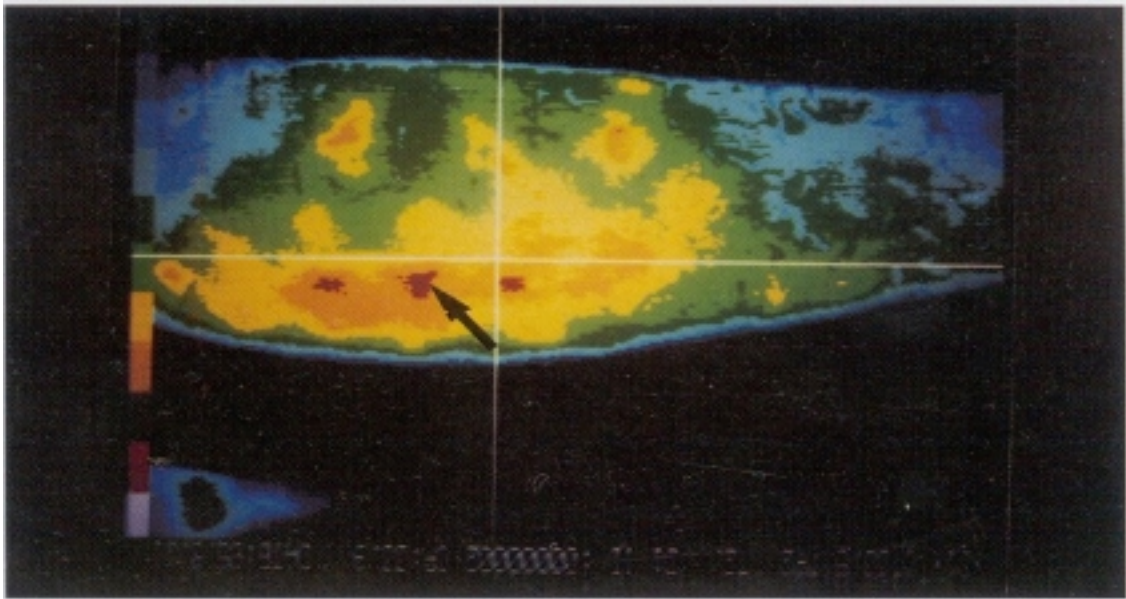
(Type III).



(3).

Type III

Type I



(4).

(穿通枝)

(,)

3

(4)

(遊離皮弁)

(3)

1)

가)

thermal recovery

가

4).

)

thermal recovery

hot spot가

hot spot

2)

(遠位端) 가
가
(遠位端) (
가
가

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11.

가

(1)

1)

가

가

/

가

2)

(頸肩腕)

()

가

가)

가

)

가

가

가

가

1),

(中膜筋)

,

(内膜)

2)

3,4)

a)

, 가

,

가

가

5),

가

6),

가

(FSBP%)⁷⁾

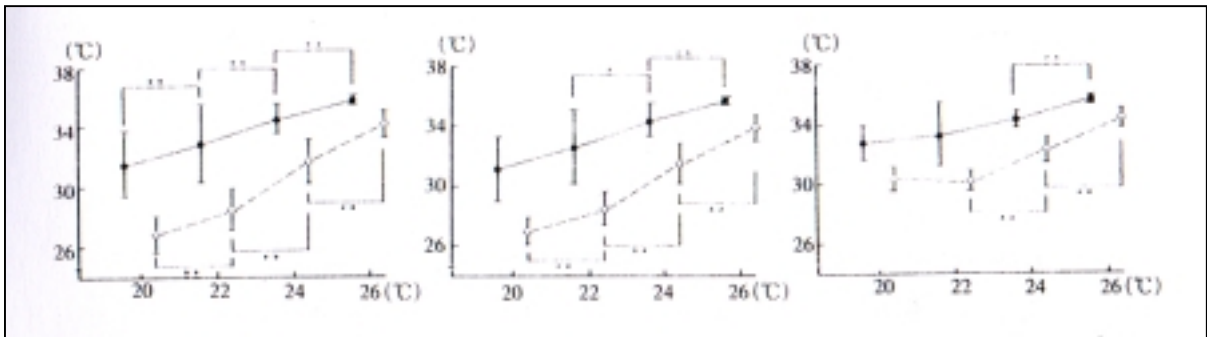
b)

(2)

가
가
26 30
5~7 24 30
22, 20 50%
0.5m INFRA-EYE 180()
0.5 5

1)

7, 6, 20, 24, 26 10 가 (DIP)
가 (1-1,
1-2, 1-3).



1-1

1-2 가

1-3

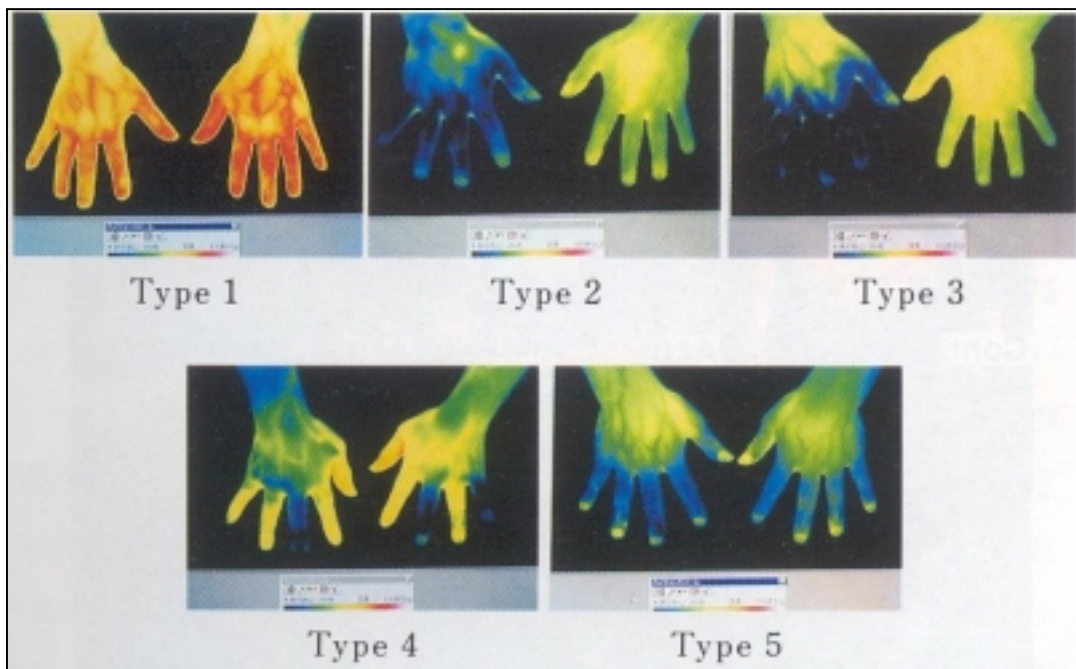
** P<0.01, *P<0.05

20, 26 DIP (1-1) 가
11.0, 8.4 가 ()
1-2) 가 가 9.8,
7.9 (1-3) 가
6.5, 5.8

가 가

2)

2 5 , (基節) MP ,
 IP , 1, 2가 (中手骨) 15
 30
 24 .
 (Type 1), 1 / 가
 (Type 2), 가 가 (Type 3), 가
 가 (Type 4), 30 (Type 5)
 5 .
 5 .



(2).

3)

40 (67.5 ± 6.2 , 12.9 ± 5.6)
 가 1. Type 1
 26 63%, 24 57%, 22 38%,

20 3% Type 1 가 .
 Type 1 Type 5 Type
 異常 가 가 20 97%가 Type 5
 가

	26	24	22	20
Type 1	25	23	15	1
Type 2	5	3	1	0
Type 3	6	2	5	0
Type 4	2	4	6	0
Type 5	0	0	1	7
Type 3, 5	1	6	9	22
Type 2, 4	1	1		
Type 2, 3		1		
Type 2, 5			2	3
Type 4, 5				5
Type 2, 4, 5			1	1
Type 3, 4, 5				1

4)

가 가 가
 (FSBP%) FSBP% strain-gauge Plethysmography DM
 2000(Medimatic) 3 가 10 5
 가
 FSBP% 24 75%
 , 75% 異常

가)

24 FSBP%가 75%
 Type 1
 (2). 26 57.1%, 24
 66.7%, 22 76.2%, 20 100.0%가
 84.2%, 84.2%, 57.9%, 5.3% .
 2
 26 24 22 20
 57.1% 66.7% 76.2% 100.0%
 84.2 84.2 57.9 5.3

가 가
 가 24
 가

) 가 가 가

24 FSBP%, (5, 15~20), (5, 10), 4 8,9)

3. 46.5% 70 24

3. 가 85.3%

3 가 가

		85.3%	46.5%
FSBP%		88.2	
	(5, 10)		
5		5.9	97.7
10		50.0	69.8
	(5, 15~20)	85.3	55.8

, 가 24

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12.

(1)

1)

(鍼灸)

가

黃帝內經() 傷寒論()

가

가 言正()

가

(針)

가

2,000

가

5臟 6

三焦

想定

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異常

가 異常

(가 ,)(,)(,)

2)

(機轉)

가 가

異常

3.5

.45

가

(2) (鍼灸)

1) -

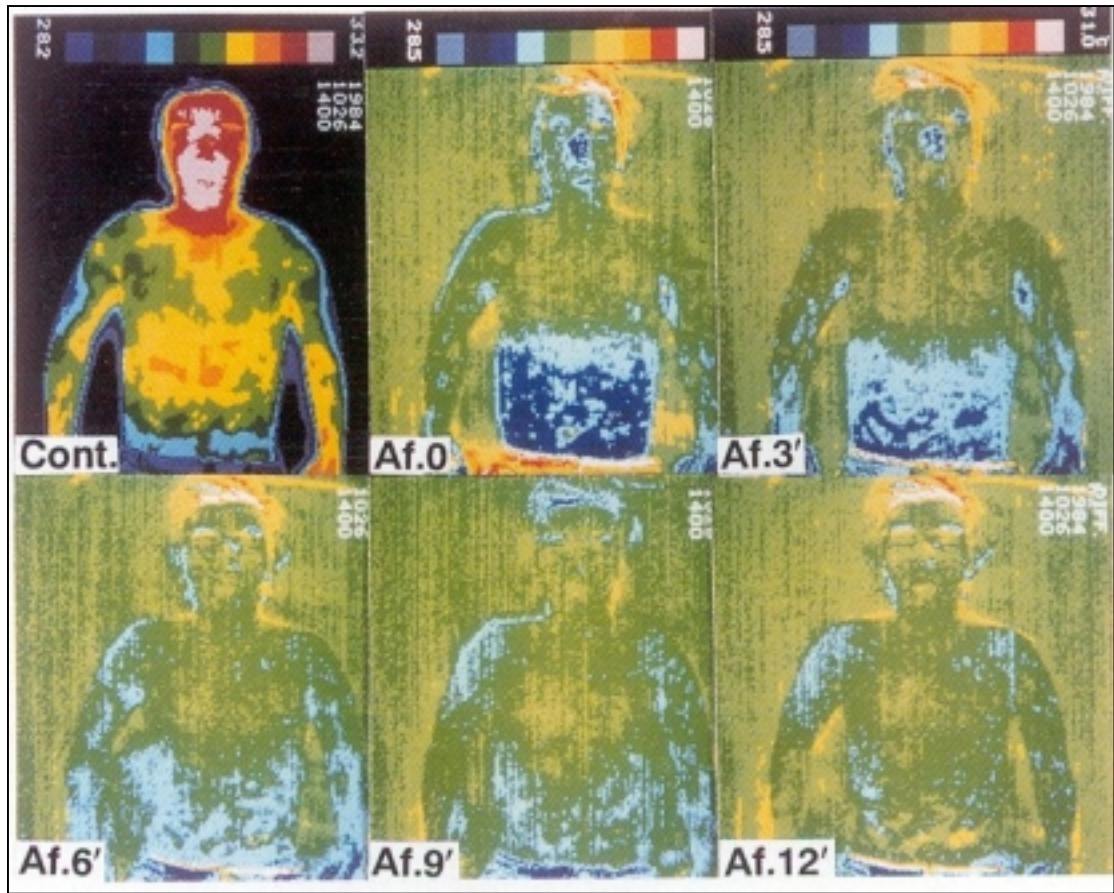
(氣 穴)

(-)

가

(,)

가 .¹⁾



(1).

(1)

가

가

()

가

2) (鍼灸)

1~3

/
가 2).

2)

3) (鍼灸)

2

(刺鍼中),
가

3)

(波高)

가

가

가,

가

가,

가

beta

4)

5)

(臥位)

(立位)

가

가

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(臥位)

가

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(5mm

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가가

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가

가

(深刺15~20mm

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10

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가)

β

10

가

(3)

가
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6)

가
가 ?

(14 / 8)

(頸腕)

가

1~3

가

(4)

1)

(10 , 21~29)

4 . 7 . 10 . 1
7)

가

가

3

(1)

(2)

4

가

7

1

가

2)

(臥位)

(立位)

가)

8)

가

가

(立位)

()

가 2.0~3.1
) 1~2
 9) 1.7~2.7 가
 4 12
 () 가
 -
 가 -

(5) (鍼灸)

1) (鍼) 10)

143
 (,)가 < > <
 >가 가 , < >< >> >
 가 (,) 119
 가 , 12 ,
 7 , 3 , 2 - 33 ,
 28 , 가 24
 가 143 90
 62.9% < >< > 가 70.3%
 < 가 >< 가
 > 80.0%
 가 가 44 44 30
 가

2) (鍼)

가)

5 , 1 , 4 .
 가 / ()
 (後正中線)
 6 .

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1 , 5 .
 4 .

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2 , 5 , 가 3 . 7 .
 (, ,)
 가 .

3)

10)
 (30mW (照査) 1mW (照査))

40 29 (72.5%) .
 - (座位) (外關穴, ,

3) 照射

- 1) 森 英俊：サーモグラフィによる経絡経穴現象の研究, *Biomedical Thermology* 7 (2) : 217-228, 1987
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III.

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가 . NIH Image 가

가 (TIFF, PICT, JPEG, EPS)

가 , 가 . 가

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가 . 가

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가 0.01°C

가

가

가

3. 가 .

(帶域)

(帶域)

가

가

가

가

가

가

가

가

21

IV.

(infra-red imaging or thermography)

(核溫, core temperature)

(殼溫,

shell temperature)

(走査型)

, tele-

(contact thermography)

(走査型)

(microwave)

가

(Infrared imaging thermography)

(受光)

(受光) ,

(Infrared detector)

가

가

InSb

HgCdTe가

serial time

가

(contact thermography)

30~35

(temperature distribution)

(thermatomal dermatome)

가 dermatome
thermatome

體節的

異常 가 /

(high thermal area, hot area),
(cold spot)

(low thermal area, cold area)

(hot spot)

가

(pre-areolar heat)

(edge sign) 異常

(vascular pattern)

(temperature difference) , ΔT

가

(region of interest)

(maximum temperature)

(mean temperature) ,

(minimum temperature)

(temperature gradient ,heat stripe)

가

가

가

(thermographic index, TI)

()

(thermographic index, TI)

(thermographic score ,TH)

score, TH ,

TH1 TH2 , TH4 TH5 , TH3

TH1 TH5

thermographic

. TH3

가

(dynamic thermography)

(steady state thermography)

가

(serial real time)

(stress)

(thermal recovery)

가

가

가
2

가

(thermographic venography)

(reactive hyperthermia)

가

가

가 가

가

IV.

1999
80%
2
ECG Patient monitor
SRP
7
"ISO 9001"
"EN46001" "CE"
MEDICA 가
/

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