

# CLINICAL AND EXPERIMENTAL STUDIES ON RECIPROCAL ACTIONS BETWEEN ORGAN AND SKIN, ESPECIALLY FROM THE VIEWPOINTS OF ELECTRICAL SKIN RESISTANCE AND SKIN TEMPERATURE

by

SUSUMU NAKANO

From the 2nd Surgical Division, Kyoto University, Medical School

(Director: Prof. Dr. YASUMASA AOYAGI)

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## INTRODUCTION

Clinically, the knowledge of "segmentation" of the spinal cord gives sometimes a very important clue for localizing the various lesions. A firm connection of the nervous- and vascular system with the corresponding dermatoms in the early stage of the embryonal development, remains unchanged even after the individual organ moved widely away from the original location during the course of development.<sup>1)</sup>

Actually, all reflexes, from the very simple one, such as axon reflex or spinal reflex, to the more complicated one in which the medulla oblongata, mesencephalon or the cerebrum becomes involved, can not be understood without a concept of "segmentation" of the body. Also, in the clinical field, we always can recognize some viscerocutaneous reflex in a form of HEAD's dermatom or referred pain. A stimulus applied to a some part of the body, is conducted to the center through some afferent pathway, then it, in turn, is referred to the various part of the body through the efferent pathway.<sup>2)</sup>

In the visceral reflexes the spinal cord plays, no doubt, the most important role as the reflex center, HEAD's dermatom is believed to be a dermal representation of a reflex, i. e. reflex in the form of viscerosensory-spinal cord-cutaneous hyperesthesia. In the strict sense, however, this may differ slightly from the concept of a true reflex which is usually formed by the reflex arc of "receptor-sensory afferent-center-motor efferent-effector organ". However, some investigators consider this HEAD's dermatom as a reflex with the following reflex arc: viscerosensory-center-somatomotor (which gives rise to the contraction of muscle, blood vessel and pilomotor musculature)-somatosensory response.<sup>3) 4)</sup>

Skin, covering the whole surface of a body, isolates the inner organs of the individual from the external environments. Thus, the two environments, i. e. those of inside and outside of the individual, can only interact through their boundary wall, skin. Therefore, a careful analysis of the abnormal visceroc-

cutaneous reflex referred to the skin, can give us a fairly accurate recognition on the pathological process occurring in a certain organ. Investigations, in this line, has been carried out from various angles, e. g. through the study on the dermal hyperesthesia, conditions of sweating or on the neurotrophic conditions of the skin.

In this study, I also studied this problem, through the determination of the electrical skin resistance (E. S. R.) by direct current.

There are so many arguments concerning the meanings of the electrical skin resistance.<sup>5)</sup> It seems, however, to be quite certain that E. S. R. takes its origin almost wholly from the epidermis, and the conditions of the sweat gland,<sup>6)</sup> content of sweat or the conditions of the sebaceous glands may all give some influences upon E. S. R.. Among all, however, there is a wide agreement that the changes in the conditions of the sweat gland give the most decisive effects on increase or decrease of E. S. R.. Accordingly, E. S. R. can be influenced by the tonicity of the sympathetic nerve, or by changes of skin temperature, or also by the change of the environmental temperature.

RICHTER studied on the relation between E. S. R. and the various physiological factors.<sup>8)9)</sup> Also, SERA<sup>13)</sup> performed a systematic investigation of the similar sort, using the normal and pathological materials. Regarding to the interrelation between dermatom and spinal cord, or about the technical matters of this problem, there are found reports by CROON,<sup>10)</sup> KORR and THOMAS.<sup>11)12)</sup> Besides these, many other reports concerning E. S. R. changes in various neurological diseases,<sup>14)</sup> e. g. after peripheral nerve cutting,<sup>15)</sup> in postoperative sensory disturbances,<sup>6)</sup> in vascular diseases and in various skin diseases especially of leprosy, have been published.<sup>17) 18)16)20)21)</sup>

In the present study, I examined E. S. R. in the various parts of the body, either in normal individuals or individuals under the pathological or abnormal environments. Results obtained, were quite similar to those by SERA or others.

At the next step, I studied on the localized changes in E. S. R., in the patients who were suffering from the diseases of some particular organs, and I tried to correlate the locations with abnormal E. S. R. and the hyperesthetic zone of the skin.

## METHODS

While SERA used the apparatus of dermometry designed by YASUJI KATSUKI,<sup>22)</sup> I used in this study, a different machine as shown in Fig. 1.

Electrical skin resistance of the body is very unstable due to its polarity.<sup>24)25)26)27)</sup> By the change in voltage applied, or by the direction of the electric stream, determination values vary considerably.<sup>23)</sup> Thus, it is necessary to apply a constant voltage throughout each test. For this purpose, I devised a special type of switch (V), shown in Fig. 1, using a single 1.5 v. battery. Cathode was always applied to the left ear lobe as the indifferent pole. Anode was simply applied or fixed with adhesive tape on the skin surface at the point where E. S. R. was to



Before the determination, patients were ordered to lie down on the bed quietly for approximately 20 minutes. Room window was covered by the black curtain and the patients were kept away from noise as much as possible. Room temperature was regulated at 20°-24°C except in the summer season, and humidity was kept between 50-70 % as far as it was possible.

The values determined with the dermometer was calculated into the values of resistance by the graph. Sometimes, however, for example in case when the comparison of the values just before and after a certain procedure was necessary, the values obtained by dermometer were used by themselves without computing them into the resistance values. The actual value obtained in each dermometric measurement varies greatly according to the changes in voltage, ampere, kind of electrode, or direction of electric stream used.<sup>23)12)</sup> Thus, the comparison of two or more values is possible only when these are obtained under exactly same basic conditions at a measurement.

Almost always determination of skin temperature was carried out simultaneously with the use of thermo-couple. (0.3 mm Copper-Constantan wire, and  $5.8 \times 10^{-6}$  v., 4.6 ohm micropylometer was used.) For the measurement of temperature of the alimentary tract, the thermo-couple was covered with NELATON'S catheter. After inserting this catheter-coated thermo-couple to the site to be measured, only the catheter was withdrawn leaving the thermo-couple in position. For applying the warm stimulus upon the skin small metal warmer (8.5 × 4.5 × 0.6 cm, 42°-47°C) or eye-compress was used. For the stimulation of buccal mucosa small rubber bag was placed at the proper point in the mouth, and ice-water (5°-10°C) or hot-water (50°-55°C) was irrigated into this bag through the two thin polyethylene tubes connected.

## RESULTS

### CHAPTER I

#### **Influences of various organ disorders upon the skin.**

The hyperesthetic zone or referred pain on the skin are quite often observed in the various organ disorders. In order to determine whether these might be associated with the actual changes in sweat or sebaceous glands or the blood vessels, the electrical resistance of the skin was determined.

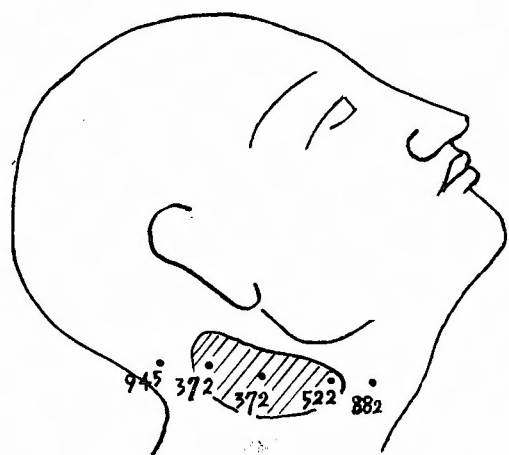
#### 1) Disease of pharynx

5 cases of the tonsillitis were studied. It is well known that in the course of the tonsillitis, one often experiences the feeling of dullness at the shoulder, or hyperesthetic zone in the neck or submaxillary area. Further by a digital compression or by injection of novocaine to these spots various discomforts sometimes disappear.<sup>19)30)31)</sup>

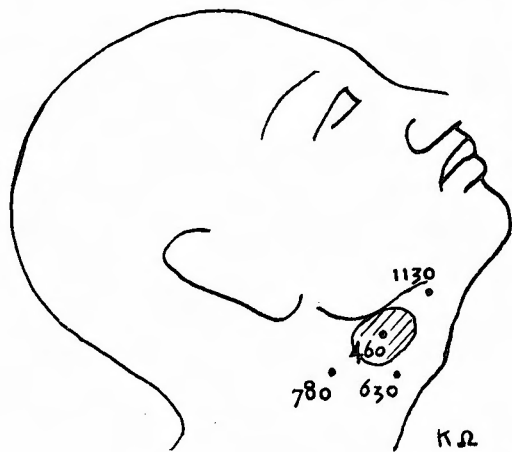
In the present study, decrease in E. S. R. were observed in 3 cases (cases No. 3, 4, & 5) (Tab. 1, Fig. 2). In one case (case No. 3) the area with decreased E. S. R. disappeared 7 days after the disease was cured.

**Tab. 1** Pharyngeal disease

No.	Name	age · sex	disease	decrease in E S R	temp. hum.	date
1	O	4 ♂	tonsillitis (bilateral)	—	19°, 58	56. 11. 20
2	K	7 ♂	tonsillitis (right)	—	19°, 58	56. 11. 20
3	S	27 ♂	tonsillitis (bilateral)	+ (bilateral submaxillary area)	20°, 60	56. 11. 30
4	O	38 ♂	tonsillitis (right)	+ (right submaxillary area)	20°, 60	56. 11. 30
5	I	30 ♂	tonsillitis (bilateral)	+ (right submaxillary and neck area)	20.5°, 61	56. 12. 20



**No 5**



**No 4**

**Fig. 2** Area of decreased E S R in patients of tonsillitis.

2) Diseases of the thoracic organs

Patients who are suffering from the heart disease, often complain about the unpleasant feeling in chest. Also during the episode of heart attack in angina pectoris, patients often have pain or hyperesthetic area in the sternal region. And further, by cooling these places of hyperesthesia, some improvement of symptoms often follow.

**Tab. 2** Heart disease

No.	Name	age · sex	disease	decrease in E S R	temp. hum.	date
1	M	43 ♀	myodegeneratio cordis	+ (left lateral chest wall)	25°, 73	56. 6. 10
2	K	58 ♂	hypertension with coronary sclerosis	—	23°, 70	54. 6. 18
3	K	59 ♂	coronary sclerosis	—	25°, 67	56. 10. 16
4	N	45 ♀	myodegeneratio cordis with acute nephritis	+ (left lateral chest wall and shoulder)	30°, 82	56. 8. 27
5	M	54 ♂	hypertension with aortic insufficiency	—	23°, 63	57. 2. 10
6	N	34 ♀	mitral stenosis	—	25°, 60	54. 5. 6
7	H	55 ♀	hypertension with aortic insufficiency	—	22°, 58	57. 1. 20
8	S	51 ♀	mitral stenosis	—	26°, 73	53. 4. 16

In 8 cases of various heart diseases, E. S. R. were determined on the skin of the chest wall, shoulder, back and upper abdominal wall. In only 2 cases out of these (cases No. 1 & 4), decrease in the skin resistance was found in the chest wall and at the left shoulder. In these two cases serious damages of the myocardium were found electrocardiographically (Tab. 2 & Fig. 3).

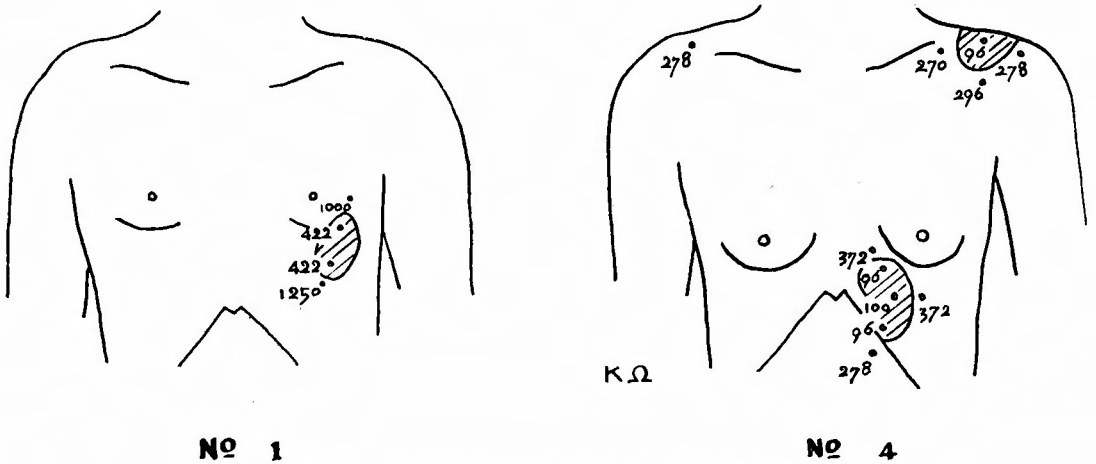


Fig. 3 Area of decreased ESR in patients of heart disease

Among the patients of pulmonary diseases, in 4 (cases No. 1, 4, 8, & 10) out of 12 cases of unilateral pulmonary tuberculosis, areas of decreased skin resistance were noticed. Same was found in one out of 2 cases of the unilateral acute bronchitis (Tab. 3 & Fig. 4). Similarly, in 2 cases among the 4 patients of ex-

Tab. 3 Pulmonary disease

No.	Name	age	sex	disease	decrease in ESR	temp. hum.	date
1	A	21	♂	right pulmonary tuberculosis	+ (left lateral chest wall)	20°, 66	53.3.12
2	Y	23	♂	right pulmonary tuberculosis	-	24.5°, 67	53.5.16
3	T	42	♀	left acute bronchitis	+ (left lateral chest wall)	21°, 62	53.2.24
4	H	58	♀	left pulmonary tuberculosis with cavity	+ (left lateral chest wall)	24°, 64	54.5.20
5	H	46	♂	right pulmonary tuberculosis	-	22°, 62	55.3.10
6	S	40	♀	left pulmonary tuberculosis	-	23°, 60	55.3.12
7	O	25	♂	left pulmonary tuberculosis	-	28°, 76	55.7.10
8	Y	26	♂	right pulmonary tuberculosis	+ (right shoulder)	23°, 62	53.5.14
9	Y	67	♀	right pulmonary tuberculosis with cavity	-	23°, 62	53.5.14
10	K	25	♀	right pulmonary tuberculosis	+ (right lateral chest wall)	30°, 78	54.8.10
11	M	19	♀	right pulmonary tuberculosis	-	28°, 74	54.9.10
12	K	18	♂	right pulmonary tuberculosis	-	28°, 74	54.9.10
13	K	26	♂	left pulmonary tuberculosis	-	28°, 76	55.7.10
14	N	23	♀	left acute bronchitis	-	20°, 62	55.3.9

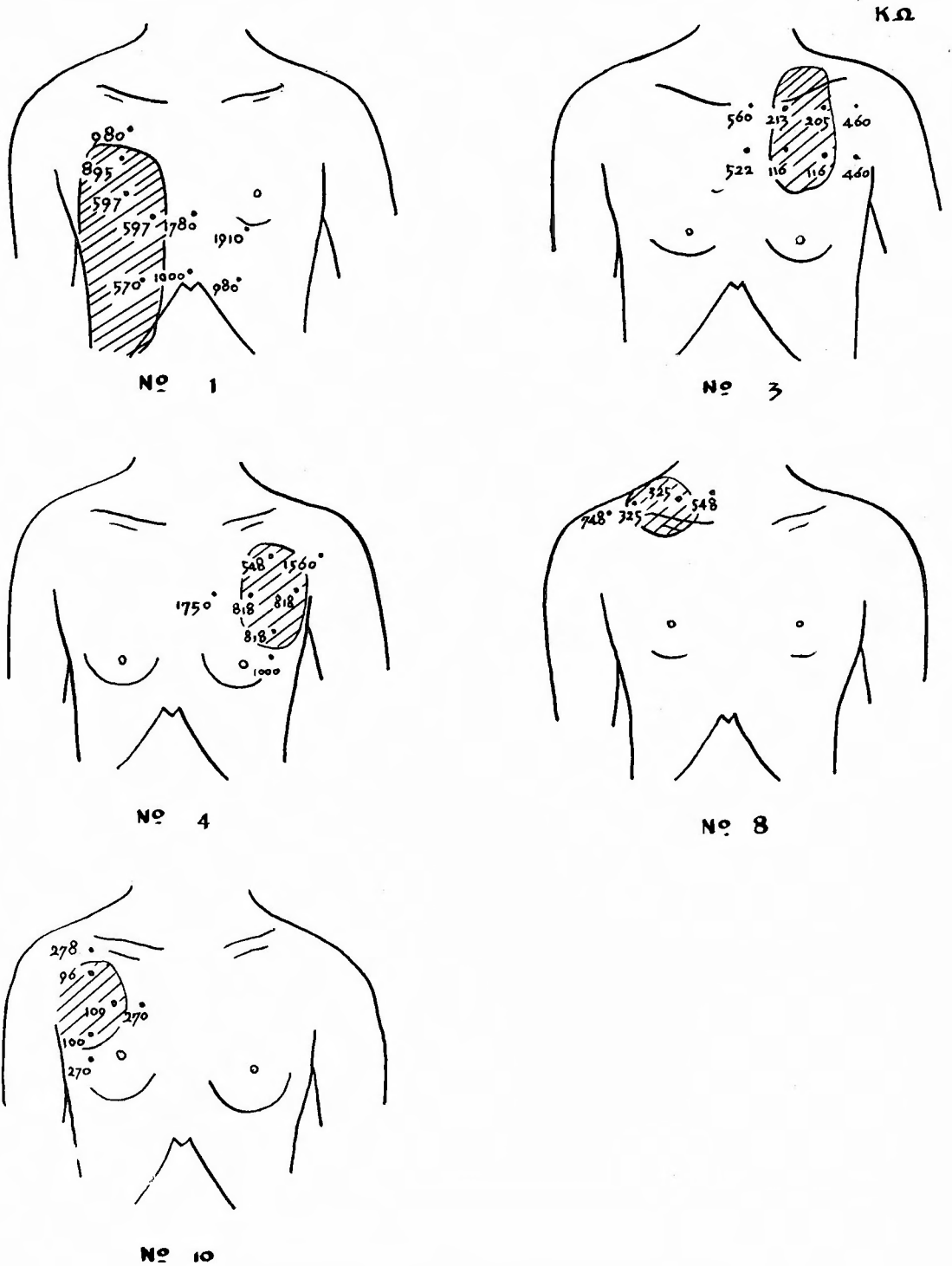


Fig. 4 Area of decreased ESR in patients of pulmonary disease

sudative pleurisy, areas in which the E. S. R. was definitely lower compared with that of corresponding parts on the opposite side, were noticed in the lateral chest wall and on the shoulder (Tab. 4 & 5).

Tab. 4 Pleural disease

No.	Name	age·sex	disease	decrease in ESR	temp.·hum.	date
1	T	19 ♂	right phrenicopleurisy	+ (right shoulder)	19°, 69	53. 2. 5
2	H	25 ♂	right pleurisy	+ (right lateral chest wall)	26°, 65	56. 7. 9
3	W	38 ♂	right pleurisy	-	21°, 58	56. 2. 1
4	S	17 ♀	right pleurisy	-	26°, 63	54. 9. 15

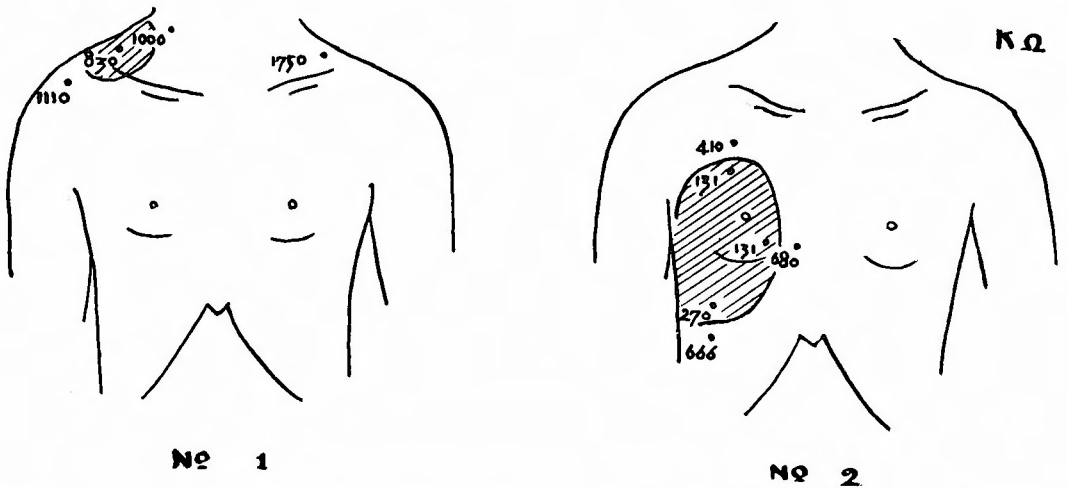


Fig. 5 Area of decreased ESR in patients of pleural disease

3) Diseases of abdominal organs

It has long been recognized that in the various diseases of adominal organs there are found the referred pain, hyperesthetic zone, radiation of pain or spot of tenderness. M. B. DUNAIEVSKAYA studied on the changes in E. S. R. in patients suffering from the diseases of the gallbladder, duodenum and the pancreas.<sup>32)</sup> According to her description, the area of decreased skin resistance corresponds well to the point of the cutaneous projection from the affected organ, and careful examination of E. S. R. is very useful for the early diagnosis of diseases or for following up the process of inflammation of the organ.

I also carried out the similar examinations on patients who were suffering from the diseases of the various abdominal organs.

i Disease of stomach and duodenum

24 cases were examined in this study. In 4 out of 12 cases of the stomach ulcer, the areas with decreased E. S. R. were found in the upper abdominal region (in 2 cases), in the bilateral paravertebral area (in 1 case), and both in the upper abdominal region and at the BOAS'S point (in 1 case). Similarly, among 5 cases



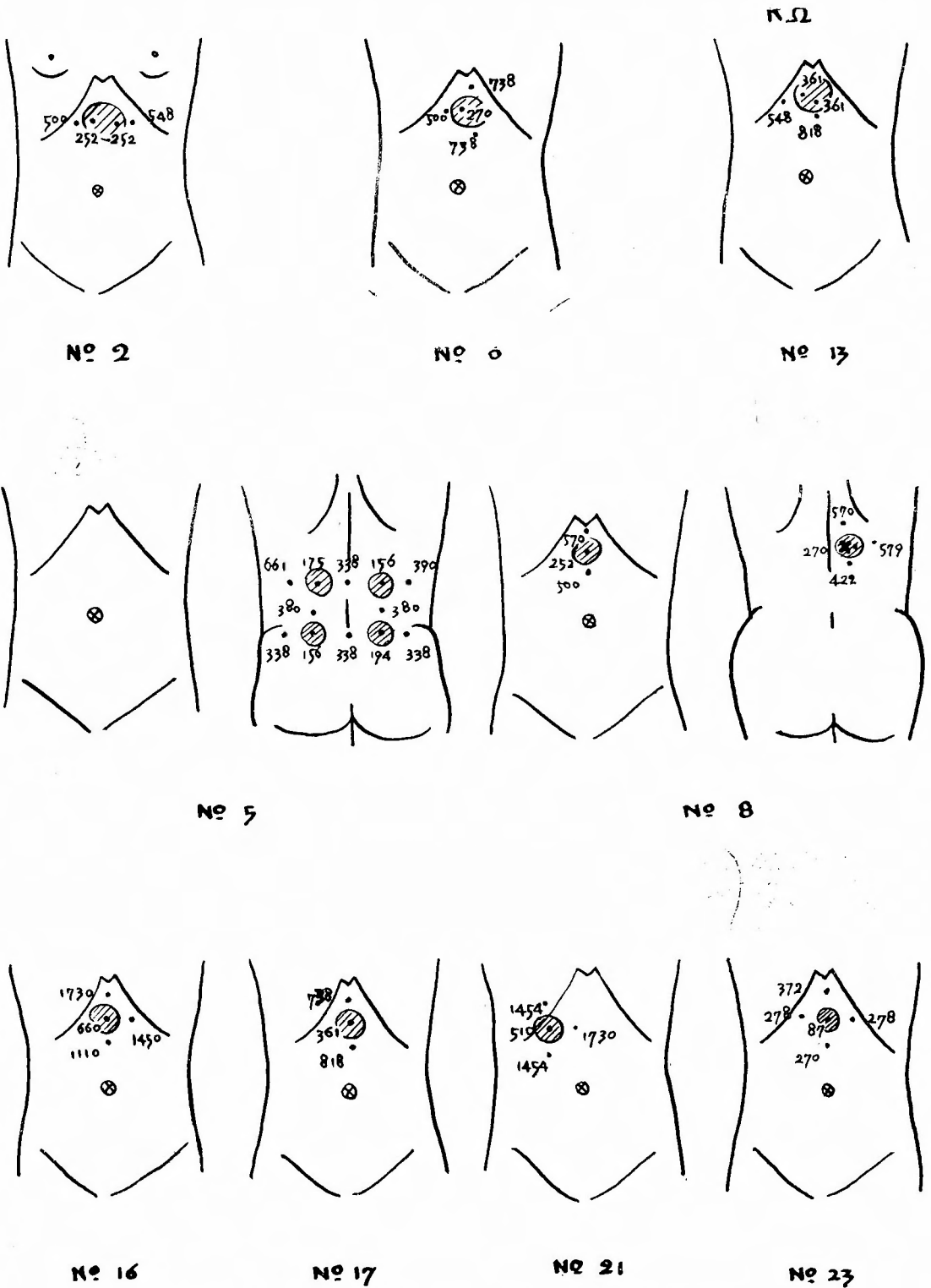


Fig. 6 Area of decreased ESR in patients of gastroduodenal disease

of stomach cancer and polyp, an area of decreased E. S. R. was found in the upper abdominal wall in 2 cases. Same thing was noticed, in 1 out of 3 cases of duodenal ulcer (in the upper abdominal region), in 2 among 4 patients of chronic gastritis and gastroptosis (1 in the upper abdominal region, 1 at the right costal margin). No significant decrease in E. S. R. was noticed in 5 patients of acute gastritis (Tab. 5 & Fig. 6).

Tab. 5 Gastroduodenal disease

No.	Name	age	sex	disease	decrease in ESR	temp. hum.	date
1	S	40	♀	gastric ulcer	—	25°, 70	53. 5. 30
2	K	38	♂	gastric ulcer	+ (upper abdomen)	25°, 70	53. 5. 30
3	S	56	♀	gastric ulcer	—	28°, 67	53. 6. 10
4	T	37	♀	gastric ulcer	—	24°, 78	54. 9. 10
5	K	66	♂	gastric ulcer	+ (bilateral paravertebral area (T <sub>12</sub> , L <sub>5</sub> ))	24°, 78	54. 9. 10
6	K	39	♂	gastric ulcer	+ (upper abdomen)	25°, 60	55. 5. 7
7	Y	40	♀	gastric ulcere	—	24°, 67	55. 5. 11
8	O	57	♂	gastric ulcer	+ (upper abdomen and Boas's point)	24°, 67	55. 5. 11
9	I	31	♀	gastric ulcer	—	20°, 62	56. 4. 10
10	K	43	♂	gastric ulcer	—	20°, 62	56. 4. 10
11	O	32	♂	gastric ulcer	—	23°, 71	57. 5. 21
12	M	28	♂	gastric ulcer	—	23°, 71	57. 5. 21
13	H	46	♂	duodenal ulcer	+ (upper abdomen)	25°, 60	53. 5. 6
14	O	28	♂	duodenal ulcer	—	26°, 73	53. 9. 30
15	T	62	♂	duodenal ulcer	—	21°, 48	56. 11. 10
16	H	60	♂	cancer of stomach	+ (upper abdomen)	25°, 56	53. 4. 25
17	C	69	♀	stmach polyp	+ (upper abdomen)	25.5°, 66	53. 5. 27
18	O	53	♀	cancer of stomach	—	26°, 77	53. 5. 13
19	T	66	♂	cancer of stomach	—	21°, 70	53. 6. 2
20	I	60	♂	cancer of stomach	—	21°, 76	54. 6. 2
21	Y	41	♂	chronic gastritis	+ (right hypochondrium)	20°, 70	53. 3. 24
22	Y	24	♂	chronic gastritis	—	31°, 83	53. 8. 80
23	H	63	♂	chronic gastritis	+ (upper abdomen)	30°, 74	54. 8. 10
24	K	43	♀	gastroptosis	—	25°, 65	54. 6. 16

## ii Disease of intestinal tract

As was illustrated in Table 6, the measurement was made in 9 patients.

Tab. 6 Intestinal disease

No.	Name	age	sex	disease	decrease in ESR	temp. hum.	date
1	I	45	♀	colon dyskinesia	—	22°, 62	55. 3. 20
2	K	21	♂	acute colitis	—	25°, 75	55. 6. 10
3	I	48	♀	acute colitis	+ (lower abdomen)	29°, 76	55. 7. 17
4	E	8	♀	acute enteritis	—	29°, 76	55. 7. 17
5	I	5	♀	acute enteritis	—	30°, 82	55. 8. 15
6	E	5	♂	acute enteritis	—	30°, 78	55. 8. 17
7	I	65	♀	acute enteritis	—	21.5°, 57	55. 11. 10
8	U	18	♂	spastic colitis	—	30°, 67	56. 7. 16
9	K	20	♂	terminal ileitis	—	27°, 64	57. 5. 30

Only in one case of acute colitis (case No. 3) an area of decreased E. S. R. was found in the lower abdominal region along the midline (Fig. 11).

iii Disease of appendix

16 cases of acute appendicitis were studied. In one (case No. 9) out of 10 cases whose appendix were not perforated, an area of decreased E. S. R. was found in the lower abdominal region. On the other hand, in 2 (cases No. 6 & 12) among 6 cases with the perforated appendix, the similar areas of decreased E. S. R. were found in the ileocecal and lower abdominal region respectively.

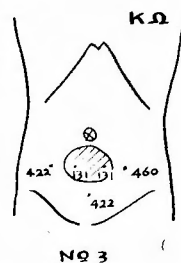


Fig. 11 Area of decreased ESR in patients of intestinal disease

Tab. 7 Disease of appendix

No.	Name	age* sex	disease	decrease in E S R	temp. hum.	date
1	T	16 ♂	acute appendicitis	-	20°, 70	53. 2. 7
2	M	20 ♂	acute appendicitis	-	16°, 67	53. 2. 9
3	W	19 ♂	acute appendicitis	-	14°, 65	53. 3. 15
4	T	22 ♀	acute appendicitis	-	14°, 65	53. 3. 15
5	S	20 ♂	acute appendicitis (perforated)	-	25°, 60	53. 5. 10
6	S	26 ♀	acute appendicitis (perforated)	+ (ileocecal area)	22°, 62	53. 4. 2
7	N	28 ♀	acute appendicitis (perforated)	-	22°, 62	53. 4. 2
8	K	17 ♂	acute appendicitis	-	24.5°, 64	53. 5. 10
9	K	19 ♀	acute appendicitis	+ (lower abdomen)	21°, 63	53. 5. 12
10	K	21 ♀	acute appendicitis	-	21°, 63	53. 5. 12
11	O	19 ♀	acute appendicitis	-	21°, 63	53. 5. 12
12	I	24 ♂	acute appendicitis (perforated)	+ (lower abdomen)	27°, 74	54. 6. 5
13	S	40 ♂	acute appendicitis (perforated)	-	26°, 76	54. 6. 30
14	S	15 ♂	acute appendicitis	-	28°, 78	54. 7. 10
15	N	46 ♂	acute appendicitis (perforated)	-	28°, 72	54. 7. 11
16	S	16 ♀	acute appendicitis	-	29.5°, 72	54. 7. 15
17	S	21 ♀	recurrent appendicitis	+ (lower abdomen)	33°, 78	56. 7. 24
18	O	44 ♂	recurrent appendicitis	-	21°, 66	56. 4. 22
19	S	19 ♀	recurrent appendicitis	-	24°, 67	56. 6. 15
20	S	15 ♂	recurrent appendicitis	+ (ileocecal area)	20°, 62	56. 3. 14
21	K	22 ♀	adhesion after appendectomy	1) before the second operation (-) 2) after the second operation (+)	14.5°, 60 12.5°, 57	53. 3. 12 53. 3. 21

Of 4 patients who suffered from a recurrent appendicitis, decrease in E. S. R. was noticed in two cases (cases No. 17 & 20) in the lower abdominal and ileocecal region respectively. Case No. 21 had his inflamed appendix removed, and was hospitalized again 8 months after his first admission because of his abdominal pain due to the adhesion. He complained pain around umbilicus, but no change in E. S. R. was found in this region. Instead, rightwards and upwards from this area, an area with definitely increased E. S. R. was found. At the second laparotomy, extensive adhesions were found between ileums or between lieum and peritoneum, and these were dissected. On the 7th postoperative day, E. S. R. was

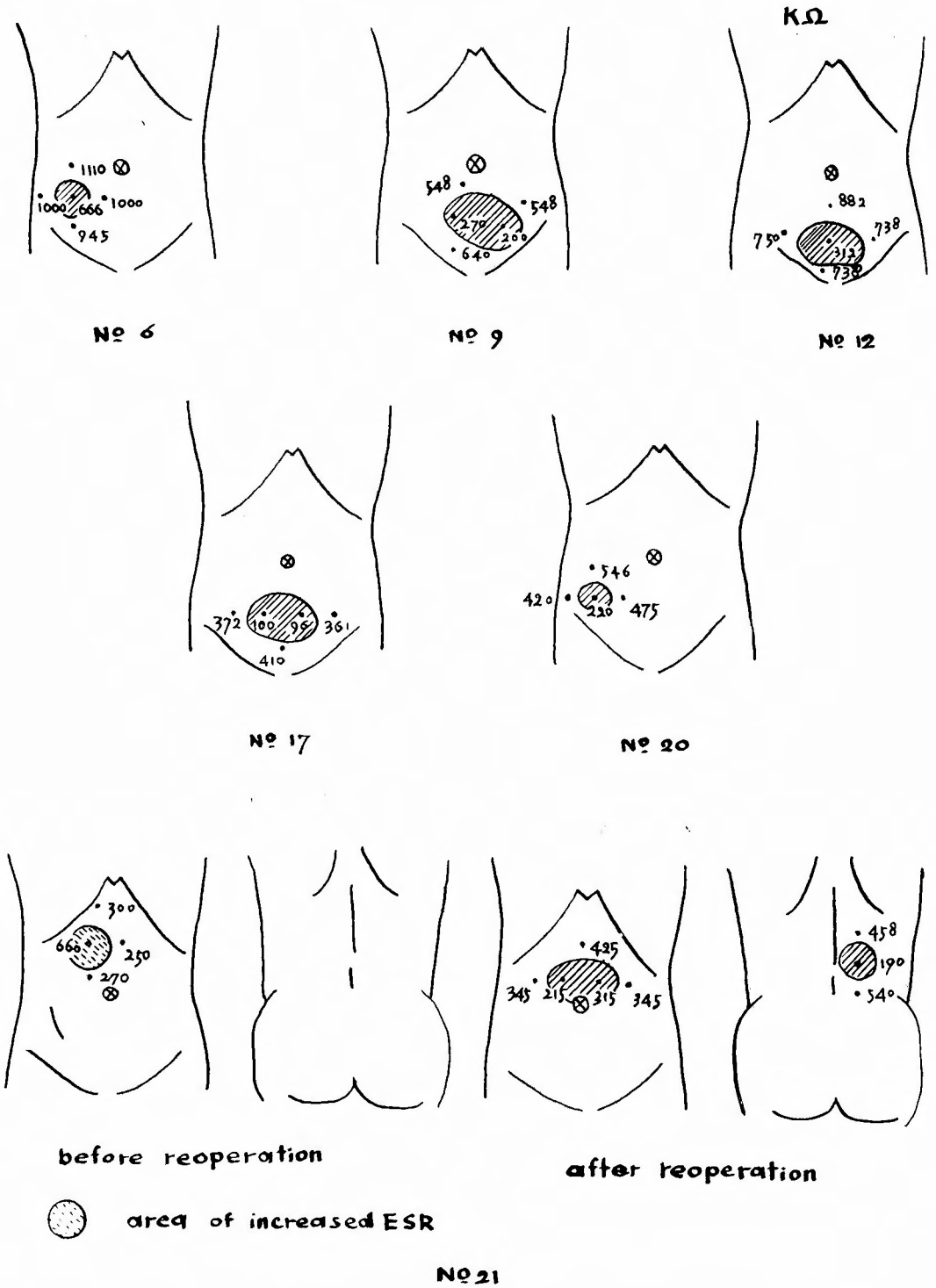


Fig. 7 Area of decreased ESR in patients of appendicitis

reexamined. This time, an area of increased E. S. R. which had been found preoperatively, was no more observed, instead, the areas of decreased E. S. R. were found above the umbilicus and in the right paravertebral region.

iv Disease of liver

3 cases who had acute liver trouble with jaundice were examined in this study. In one (case No. 2) of these 3 cases a small area of decreased E. S. R. was noticed in the right paravertebral region (Tab. 8 & Fig. 8).

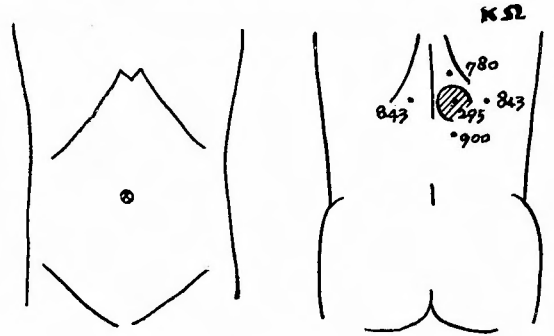


Fig. 8 Area of decreased ESR in patient of liver disease

Tab. 8 Disease of liver

No.	Name	age · sex	disease	decrease in E S R	temp. · hum.	date
1	Y	45 ♂	serum hepatitis	—	26°, 66	55.10. 7
2	N	30 ♀	acute hepatitis	+ (right paravertebral area)	28°, 74	56. 9.12
3	I	26 ♂	acute hepatitis	—	26°, 64	56. 9.20

v Disease of gallbladder

All 6 cases of cholelithiasis and acute cholecystitis were examined. In two

Tab. 9 Disease of gallbladder

No.	Name	age · sex	disease	decrease in E S R	temp. hum.	date
1	F	28 ♀	cholelithiasis	+ (upper abdomen and both shoulder)	23°, 64	53. 3.24
2	O	41 ♀	acute cholecystitis	+ (right hypochondrium)	22°, 66	53. 5.21
3	H	66 ♀	cholelithiasis	—	24°, 61	55. 4.12
4	K	57 ♀	cholelithiasis	—	25°, 63	55. 5.18
5	Y	53 ♀	acute cholecystitis	—	20°, 57	56.11. 8
6	U	44 ♂	acute cholecystitis	—	20°, 57	56.11. 8

cases, one from each group, there were found the spots of decreased E. S. R. (case No. 1; at the both shoulders and in the upper abdominal region, case No. 2; in the right hypochondrial area). These two cases were constantly complaining about the unpleasant feeling in the right hypochondrial area during their episode-free periods (Tab. 9 & Fig. 9).

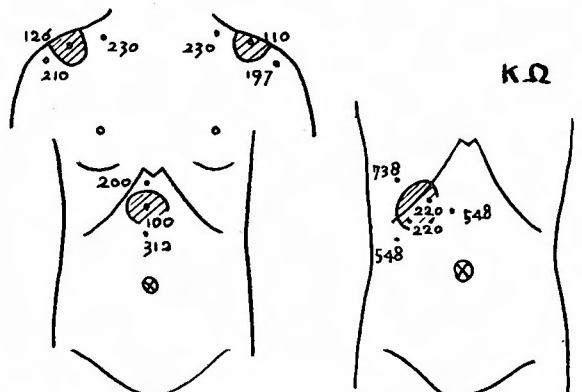


Fig. 9 Area of decreased in patients of gall bladder disease

vi Disease of pancreas

Tab. 10 Pancreatic disease

No.	Name	age	sex	disease	decrease in ESR	temp. hum.	date
1	K	34	♂	chronic pancreatitis	+ (upper abdomen)	21°, 68	53. 5.31
2	M	36	♀	acute pancreatitis	+ (left hypochondrium)	15°, 48	53. 3.28

Spot or zone of decreased E. S. R. was found in one case of acute pancreatitis in the area corresponding to the HEAD's dermatom and in one of chronic pancreatitis in a relatively wide area of the upper abdomen. Case No. 1 had been misdiagnosed and treated for 5 years as having a gastric ulcer (Tab. 10 & Fig. 10).

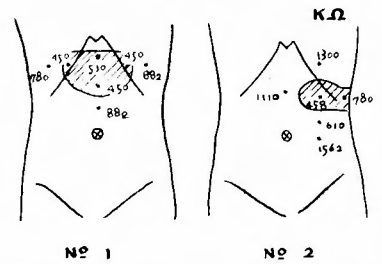


Fig. 10 Area of decreased ESR in patients of pancreatic disease

4) Diseases in urogenital organs

5 cases of kidney disease, and 4 cases of urinary bladder disease were studied. Positive result was obtained in one case of the former (in the both lumbal areas),

Tab. 11 Diseases of urogenital organs

No.	Name	age	sex	disease	decrease in ESR	temp. hum.	date
1	T	41	♀	nephrosis	-	34°, 81	55. 8. 6
2	M	11	♂	tuberculosis in right kidney	+ (bilateral lumbar area)	24°, 77	55.10.20
3	N	53	♀	acute nephritis	-	22°, 72	56.11. 9
4	F	12	♀	nephrosis	-	22°, 72	56.11.10
5	O	8	♂	nephrosis	-	22°, 72	56.11.10
6	S	52	♀	chronic cystitis	-	24°, 77	55.10.20
7	M	56	♂	chronic cystitis	+ (lower abdomen)	20°, 62	56. 1.20
8	K	23	♀	acute cystitis	-	24°, 70	56.11.15
9	N	25	♀	acute cystitis	-	20°, 74	56.11.20

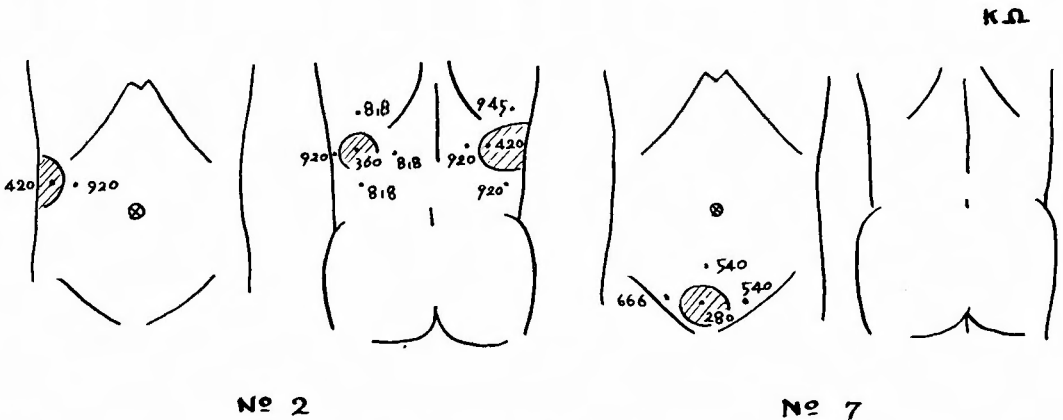


Fig. 12 Area of decreased ESR in patients of diseases in urogenital organs

and in one case of the latter (in lower abdominal wall). Both of them were suffering from the chronic diseases, i. e. one from tuberculosis of right kidney and the other from chronic cystitis (Tab. 11 & Fig. 12).

### 5) Comments

As mentioned above, E. S. R. was examined in the patients who were suffering from diseases of various organs. In some of these patients, the localized area of decreased E. S. R. could be found. These areas with decreased E. S. R. corresponded fairly well to the skin area which belonged to the same segment as that of the affected organ. It may be reasonable to think that the abnormal afferent impulses from the affected organ are conducted to the corresponding segment of the spinal cord, and the efferent impulses originated there or in the still higher center will be projected to the skin. This probably gives rise to the changes in the sweat gland, further resulting in decrease in E. S. R..

Decrease in E. S. R. were found in the submaxillary area in diseases of the pharyngeal organs, in the left chest wall or at the left shoulder in the heart diseases, and in the lateral chest wall on the ipsilateral side or at the left shoulder in diseases of the lung or pleura. These are the places at which the patients often have various feelings of discomfort, and also are the points on which the patients often apply the wet pack.

In diseases of stomach or duodenum, similar points of decreased E. S. R. were found in the upper abdominal wall, right hypochondrial area and in the back at the same height of the stomach. In diseases of intestine, these were found in the lower midabdomen, while in diseases of appendix, they were seen either in the lower abdominal wall (in non-perforated appendicitis, appendicitis of recurrent type and in one case of perforated appendicitis) or in the ileocaecal area (in perforated cases and in one case of appendicitis of recurrent type). In a patient suffering from the abdominal adhesion, the surgical dissection was followed by remarkable changes in E. S. R.. Decrease in E. S. R. was also seen in the right paravertebral area, in the patients of liver diseases. In the patients of gall bladder diseases, similar changes in E. S. R. were noticed at the both shoulders, upper abdominal wall, right hypochondrial area and at the HEAD's hyperesthetic zone. In diseases of the pancreas they were found either in the upper abdominal wall or at the HEAD's dermatom. Similarly, these changes were noticed in the lumbal areas in the chronic kidney disease and in the lower midabdominal wall in the disease of the urinary bladder.

These changes in E. S. R., however, could not necessarily be found in all cases examined. Also in the group in which positive E. S. R. changes were noticed the majority of the patients were suffering from the somewhat chronic diseases.

These findings may suggest that in the acute stage, the impulses originated from the affected organ may be so intensive or so frequent that they not only stimulate the nerve cells of corresponding segment but spread widely to those in the upper or lower segment. Consequently, it might be hard to find a localized

area of E. S. R. change on the skin surface of these patients. In many instances, areas of decreased E. S. R. corresponded to the points of tenderness on digital pressure (gastric ulcer, cancer of stomach, perforated appendicitis, appendicitis of recurrent type, acute cholecystitis, pancreatitis and chronic cystitis), while in others (appendicitis, cholelithiasis and acute colitis) it was not the case.

The latter findings may probably have something to do with the fact that in these diseases the localization of pain is sometimes rather obscure, and the patients only complain a generalized abdominal pain or pain in the vague location.<sup>32)</sup>

In many instances, E. S. R. changes were noticed in an area to which the pain usually radiated from the affected organ (diseases of the heart, pleurisy, lung tuberculosis, cholelithiasis).

In diseases of abdominal organs, E. S. R. changes were sometimes found at one or several localized spots in the paravertebral area. Some of these corresponded fairly well to the BOAS's point (gastric ulcer, adhesion following appendectomy, acute hepatitis).

In the patient of tuberculosis of the kidney on one side, the area of decreased E. S. R. was found in the lumbal area bilaterally. Impulses from the organ on one side reached the corresponding segment level of the spinal cord and efferent impulses might be discharged from there bilaterally.

In some cases, change in E. S. R. was found in very localized area, but in others, it was proved in a fairly wide zone. Also any definite rule or correlation could not be drawn between the locations and natures of E. S. R. changes and kinds of the affected organs. Also since the incidence of the occurrence of these E. S. R. changes was relatively low, it may have only supplementary values in the clinical diagnosis.

In 4 patients (gastric ulcer; cases No. 7 & 8, cholelithiasis; cases No. 3 & 4) among the cases who underwent the E. S. R. determination, the local reaction of the skin in the paravertebral area to the mild chemical stimulus was also examined. Many small pieces of adhesive tape, 1.5 cm × 1.5 cm in size, were applied to the surface of the skin in the bilateral paravertebral regions at the each segment level of the spinal cord. After 24 hours, these were taken off and localized rubefaction at these spots was examined. In one case out of 4 (gastric ulcer; case No. 8), marked rubefaction was found at the BOAS's point, and this also corresponded to the point whereon the decreased E. S. R. was noticed. Degree of rubefaction in this point was much more significant than that in the corresponding point on the contralateral side or other segment level (Fig. 6 & No. 8).

Rubefaction of the skin for the weak chemical stimulus by the adhesive tape can probably be explained by the local axonreflex through the nerve which innervate the blood vessel. Thus, the somewhat irritated area of the skin by the abnormal stimulus from gastric ulcer through the viscerocutaneous reflex, probably reacted more markedly to the locally applied chemical stimulus, compared to the other areas.



CHAPTER II

**Influence of stimulation to the skin upon the organs.**

Acupuncture and Moxibustion have been widely used in China and Japan. In spite of the fact that these techniques are definitely lacking in the theoretical background, they sometimes bring considerable therapeutic effects.

In these techniques, by applying some transient or continuous stimuluses (chemical, thermal or biochemical) to the skin or to the muscle, they expect to give some favorable effects upon the organs inside of the body. Usually stimuluses used for these techniques are extremely strong in intensity, and applied to the very limited spots. These stimuluses may give rise to some humoral as well as neuronal effects, but the latter is probably greater.<sup>34)35)36)37)</sup>

Various other physico-therapies which are very widely used clinically, such as hot or cold formentation, heat ray therapy, faradotherapy or local intracutaneous injection of chemical substances especially of local anesthetic, are all applied to the patients in an intention to produce the constriction or dilation of the blood vessels of the organs through the cutaneo-visceral reflex.<sup>38)</sup>

Also many studies on the effects of the dermal stimulation upon the sensitivity or motility of the organ, or contrarily, on the effects of the stimulation to the organs upon the skin have been reported.<sup>39)40)41)42)43)</sup>

In the present study I also investigated the reciprocal influences between skin and organ.

1) Reciprocal actions between the skin and the alimentary tract.

a) Oral mucosa and skin

**Tab. 12** Oral mucosa temperature at thermal stimulation to the cheek skin in cadaver dog

No.	1		2	
sex	♂		♀	
date temp.	6.20 24.0° C		6.25 26.2° C	
side	right	left	right	left
before	28.2	28.0	27.0	27.0
2.5'	28.0	28.0	27.0	27.0
5.0'	28.2	28.0	27.0	26.8
7.5'	28.2	27.8		
10.0'	28.0	28.0	27.2	26.8
12.5'				
15.0'	27.6	28.0	27.2	27.0
17.5'				
20.0'	27.8	27.8	27.2	27.0
22.5'				
25.0'			27.0	27.0

hot stimulus applied on left cheek

cold stimulus applied on right cheek

As a preliminary experiment a fresh cadaver dog, was used. Two thermocouples were inserted in the bilateral upper buccal pouches approximating to the surface of mucosa. Hair of the cheek skin was shaved on one side whereupon the thermal stimuluses using an ice-pack or a small metal warmer was applied. As illustrated in Tab. 12, there was found no significant difference in intraoral temperature between two sides.

This result indicates that the thermal changes given to the skin of the cheek was not transmitted to the oral mucosa by the direct heat conduction.

Now, 8 human cases were used for this study. All these had the thermocouples inserted between the buccal mucosa and upper line of gingiva. Thermal stimulus was applied to the surface of the cheek skin, and intraoral temperature was determined.

In 5 cases out of 8, the significant increase of temperature on the ipsilateral oral mucosa was observed by the application of hot stimulus on the cheek skin on the one side (Tab. 13 & Fig. 13). By the application of cold stimulus, on

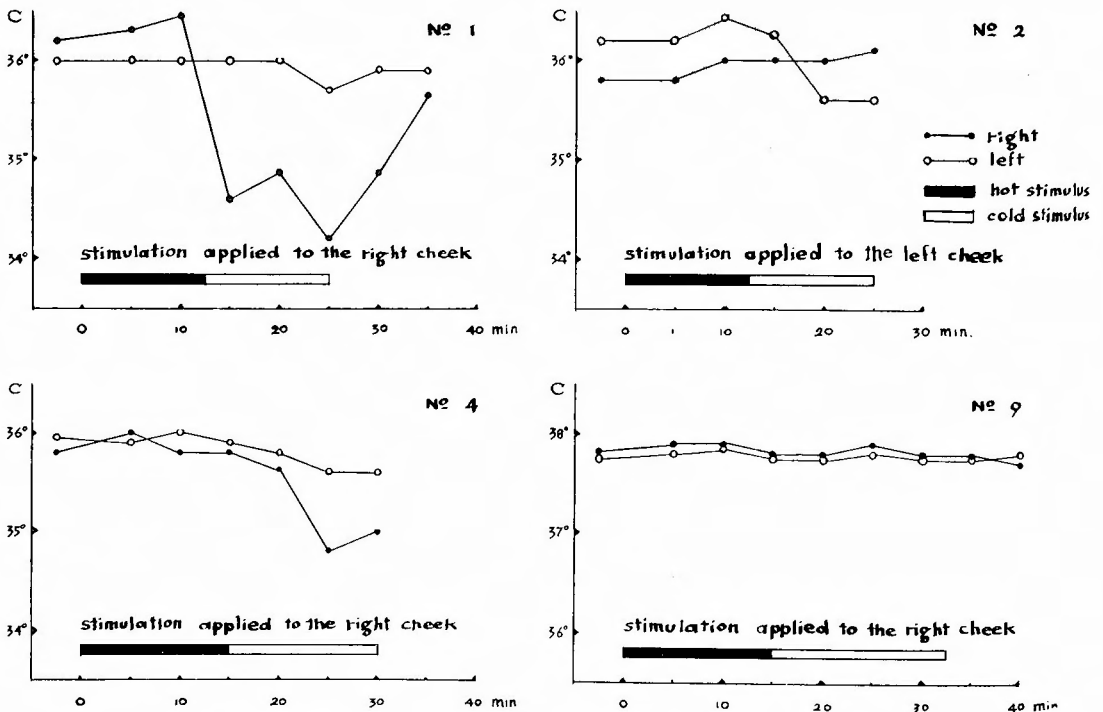


Fig. 13 Temperature change of the oral mucosa at thermal stimulation to the cheek skin

the other hand positive results were obtained in 7 cases out of 9 (Tab. 13 & Fig. 13). Then, the thermo-couples were taken out from the mouth, instead, a small rubber balloon connected with two thin polyethylen tubes was inserted. Hot or cold water was irrigated through the connected tubes and the skin temperature was determined at the both cheeks. As was seen in cases No. 1 and 2 marked

**Tab. 13** Oral mucosa temperature at thermal stimulation to the cheek skin

No.	1		2		3		4		5	
Name	I 21 ♀		N 33 ♂		N 25 ♀		U 20 ♀		O 17 ♀	
age·sex										
date	5.21		5.6		5.6		5.16		5.18	
temp.	22.6°C		23.0°C		23.0°C		24.0°C		22.8°C	
side	right	left	right	left	right	left	right	left	right	left
before	36.2	36.0	35.8	36.2	36.4	36.4	35.8	35.9	37.2	37.3
2.5'	36.2	36.0	35.8	36.2	36.4	36.4	35.8	35.9	37.2	37.3
5.0'	36.3	36.0	35.8	36.2	36.3	36.4	36.0	35.9	37.2	37.3
7.5'	36.3	36.0	36.0	36.3	36.4	36.4	36.0	36.0	37.2	37.7
10.0'	36.4	36.0	36.0	36.4	36.2	36.2	35.8	36.0	37.2	37.3
12.5'	36.5	36.0	36.0	36.4	36.2	36.2	35.8	35.9	37.0	37.1
15.0'	34.6	36.0	36.0	36.3	36.3	36.2	35.8	35.9	37.0	36.9
17.5'	34.8	36.0	36.0	36.2	36.2		35.8	35.8	37.2	36.6
20.0'	34.9	36.0	36.0	35.6	0°		35.6	35.8	37.4	36.5
22.5'	34.6	36.0	36.0	35.6			35.3	35.6	37.1	37.2
25.0'	34.2	35.7	36.1	35.6			34.8	35.6	36.0	37.1
27.5'	34.6	36.0					34.8	35.6		
30.0'	34.9	35.9					35.0	35.6		
32.5'	35.3	36.0					35.0	35.6		
35.0'	35.7	36.0								
37.5	36.2	36.0								
40.0'										

in normal conditions

No.	6		7		8		9		10	
Name	Y 17 ♀		K 24 ♂		I 28 ♂		I 20 ♂		N 33 ♂	
age·sex										
date	10.2		1.24		2.10		6.10		6.16	
temp.	22.0°C		20.5°C		20.0°C		23.0°C		22.0°C	
side	right	left	right	left	right	left	right	left	right	left
before	36.5	36.5	36.0	36.0	36.8	36.8	37.8	37.8	38.4	38.3
2.5'	36.5	36.5	36.0	36.0	36.6	36.8	37.8	37.8	38.4	38.3
5.0'	36.8	36.6	36.3	36.1	36.6	36.6	37.9	37.8	38.4	38.3
7.5'	36.8	36.6	36.4	36.1	36.6	36.8	37.9	37.8	38.2	38.3
10.0'	37.0	36.7	36.5	36.3	36.8	36.8	37.9	37.9	38.2	38.3
12.5'	37.0	36.6	36.8	36.1	36.8	37.2	37.7	37.9	38.2	38.2
15.0'	37.0	36.6	36.8	36.1	36.8	37.0	37.8	37.8	38.2	38.2
17.5'	37.0	36.5	36.8	36.1	36.8	37.0	37.8	37.8	38.2	38.2
20.0'	36.7	36.5	36.9	36.1	36.8	36.8	37.8	37.8	38.1	38.2
22.5'	36.5	36.5	36.4	36.0	36.6	36.6	37.9	37.8	38.1	38.2
25.0'	35.5	36.5	36.2	36.0	36.5	36.5	37.9	37.8	38.1	38.2
27.5'			36.0	35.9	36.5	36.5	37.8	37.8	38.1	38.2
30.0'			36.0	36.0			37.8	37.8	38.1	38.2
32.5'			35.7	36.0			37.8	37.9	38.1	38.2
35.0'			35.7	36.0			37.8	37.8	38.1	38.2
37.5'			36.0						38.2	38.2
40.0'							37.7	37.8	38.2	38.2

in normal conditions

during fevered period

h.-hot stimulus c.-cold stimulus r.-right l.-left  
(e. g. h. r. means, hot stimulus applied to the right cheek skin)

changes in the ipsilateral skin temperature were noticed by the stimulation of the oral mucosa. In one instance (case No. 1) erosion of the buccal mucosa occurred after the irrigation of hot water. Interesting enough, E. S. R. of the cheek

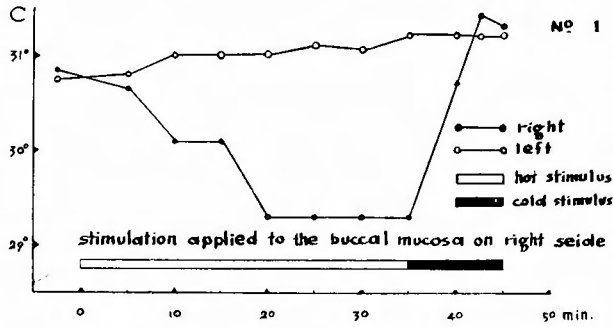


Fig. 14 Change in skin temperature of cheek at thermal stimulation to the oral mucosa

Tab. 14 Skin temperature of the cheek at the stimulation to the oral mucosa

No.	1		2	
Name	N		U	
age·sex	25 ♀		20 ♀	
date	5.25		5.26	
temp.	21.1°C		22.5°C	
side	right	left	right	left
before	30.8	30.8	31.0	31.1
2.5'	30.7	30.8	31.0	31.1
5.0'	30.7	30.8	31.0	31.1
7.5'	30.3	30.8	30.8	31.0
10.0'	30.1	31.0	30.7	30.9
12.5'	30.1	31.0	30.8	31.0
15.0'	30.1	31.0	30.8	31.0
17.5'	30.0	31.0	30.4	31.0
20.0'	29.3	31.0	29.8	31.0
22.5'	29.4	31.1	29.8	31.1
25.0'	29.3	31.1	29.5	31.1
27.5'	29.3	31.1	29.2	31.1
30.0'	29.3	31.1	29.4	31.1
32.5'	29.3	31.1	29.4	31.0
35.0'	29.3	31.2	29.4	31.0
37.5'	30.1	31.2	29.4	31.0
40.0'	30.7	31.2	30.0	31.0
42.5'	31.4	31.2	30.8	31.0
45.0'	31.3	31.2	31.2	31.0

Tab. 15 ESR in the patient with oral erosion (kn)

No.	1				
Name	N				
age·sex	25 ♀				
date	side	right	left	right	left
temp. °C					pain
5.26	24°	83	108	0.77	+
5.27	25°	78	102	0.76	+
5.29	23°	116	121	0.93	-
5.31	24°	100	102	0.98	-

skin was markedly lower on the same side of buccal erosion compared to the opposite side. In this patient oral pain due to an erosion subside on the 4th day, and no difference in E. S. R. between two sides was observed from the 5th day on (Tab. 14, 15 & Fig. 14).

b) Mucous membrane of gastrointestinal tract and skin

For this study 8 patients who had a fistula in the gastrointestinal tract were used. Among them, 3 had a fistula in the stomach, 3 in the jejunum and remainder 2 cases had a artificial anus in the sigmoid colon. Through the fistula, a rubber balloon connected with the

NELATON'S catheter or a NELATON'S catheter itself was inserted into the lumen of the stomach or intestine.

In 7 cases hot water, 42°-46°C in temperature was injected into the balloon or directly into the lumen through the catheter. Also in 3 of these patients, cold water was injected in the same fashion. Then, changes in skin temperature were examined at the segment level corresponding to that of each organ. Subjective feelings of the patients in the same area during the stimulation were also examined.

3 patients out of 7 in whom the hot stimulus was applied to the organ, felt warm sensation on the skin. In 2 out of these 3 cases increase in skin temperature was seen.

One case out of 3 in whom the cold stimulus was applied, felt cold sensation subjectively on the corresponding skin surface, but in none of these actual decrease in skin temperature was found. At the next step, thermo-couple was introduced into the lumen of the gastrointestinal tract. The corresponding skin surface was stimulated by hot water (45°-47°C) in 5 cases and by cold water (6°-7°C) in 3 cases. Changes in the luminal temperature of the organ were examined. Marked changes in organ temperature were noticed in two cases out of 5, whose skin was stimulated by hot water, but in none in the group stimulated with cold water (Tab. 16 & Fig. 19).

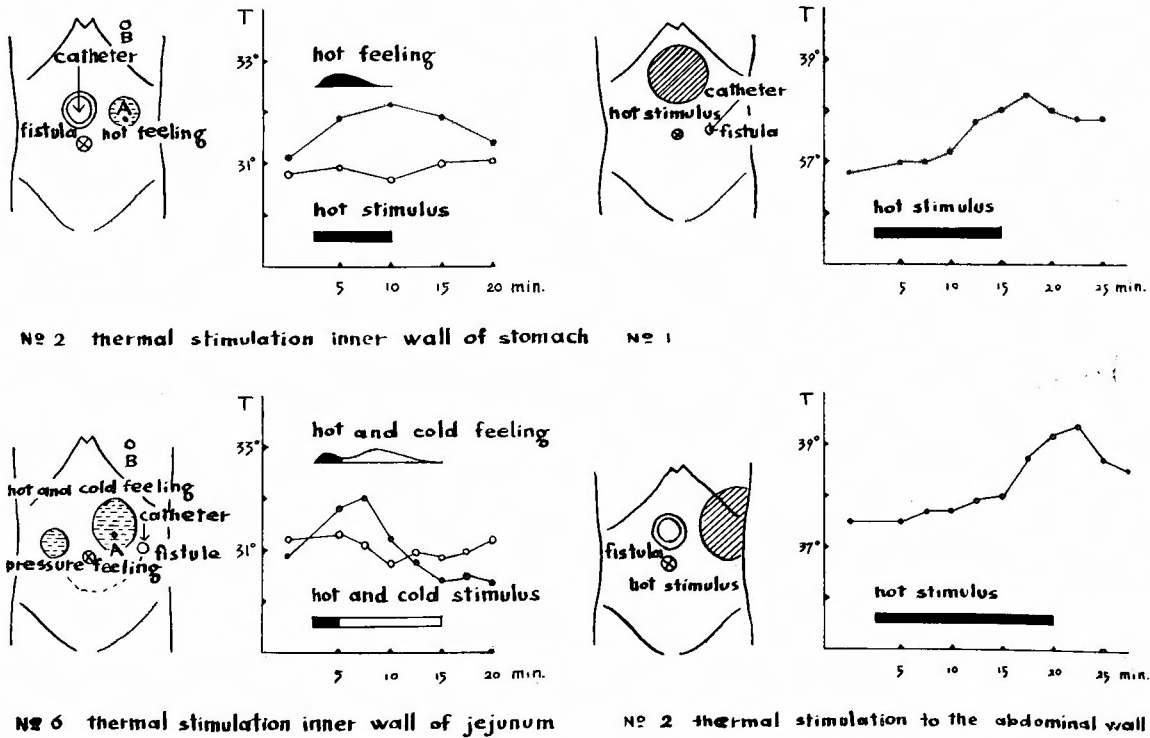


Fig. 16 Stimulation to the inner wall of the gastrointestinal tract

**Tab. 16** Reciprocal influences of temperature change between the inner wall of alimentary tract and skin

No.		1	2	3	4
Name, age, sex		K, 58 ♂	T, 37 ♂	Y, 48 ♀	I, 57 ♂
disease		mediastinal tumor	gastric ulcer	stricture of esophagus	cancer of stomach
date of examination		5.9	10.31	10.30	11.7
organ stimulated		stomach	stomach	stomach	jejunum
site of fistula		stomach	stomach	stomach	jejunum
thermal stimulation to organ	stimulus used	hot 40°	hot 45°	hot 45°	hot 45°
	subjective sensation of temperature	—	+	+	—
	change in skin temperature	—	+	—	—
thermal stimulation to skin	stimulus used	hot 45°	hot 45°		
	change in temperature of organ	+	+		

No.		5	6	7	8
Name, age, sex		N, 40 ♀	K, 61 ♂	T, 60 ♂	T, 46 ♂
disease		gastric ulcer	cancer of stomach	cancer of rectum	cancer of rectum
date of examination		4.30	5.10	4.29	4.30
organ stimulated		jejunum	jejunum	sigmoid colon	sigmoid colon
site of fistula		jejunum	jejunum	sigmoid colon	sigmoid colon
thermal stimulation to organ	stimulus used	hot 45° cold 6°	hot 45° cold 10°	hot 46°	cold 4°
	subjective sensation of temperature	—	+	—	—
	change in skin temperature	—	+	—	—
thermal stimulation to skin	stimulus used	hot 45° cold 6°	cold 7°	hot 7°	hot 45° cold 6°
	change in temperature of organ	—	—	—	—

## 2) Lung and skin

For this study, only the experimental animals, adult dogs weighing 7.5–10 kg, were used. As the premedication, 0.8 g of Isomital was per-orally administered and 0.1 g of Mintal was injected intravenously. Dog was then fixed on the table in a supine position.

Thermo-couple coated with the specially devised needle was inserted deeply into the lung (approximately 7 cm) through the skin at the 4th intercostal space. Then, the needle pulled off leaving the thermo-couple in position. Insertion of the thermo-couple was made bilaterally. Approximately 15 minutes later, ice-pack (3°–5°C) was put on the shaved skin surface in the left chest wall and the changes in temperature of the lung were registered. After a certain period of interval hot formentation using a warmer (45°C) was applied to the same skin

area and determination of lung temperature was carried out in the same fashion.

As illustrated in Tab. 17 and Fig. 15, considerable increase or decrease in lung temperature was found ipsilaterally to the side of skin stimulation. There

**Tab. 17** Change in intrapulmonary temperature at the thermal stimulation to the chest wall in dogs

No.	4				5			
date	6.2		22° C		6.10		24° C	
temp.	right	left	right	left	right	left	right	left
side	right	left	right	left	right	left	right	left
before	37.0	37.1	37.7	37.5	37.7	37.5	37.7	37.5
2.5'	37.0	37.1	37.7	37.5	37.7	37.5	37.7	37.5
5.0'	37.0	37.1	37.6	37.4	37.6	37.4	37.6	37.4
7.5'	37.0	36.8	37.6	37.4	37.6	37.4	37.6	37.4
10.0'	37.0	36.8	37.6	37.2	37.6	37.2	37.6	37.2
12.5'	37.0	36.7	37.7	37.0	37.7	37.0	37.7	37.0
15.0'	37.0	36.7	37.8	37.0	37.8	37.0	37.8	37.0
17.5'	36.7	36.3	37.7	36.7	37.7	36.7	37.7	36.7
20.0'	37.0	36.7	37.6	36.7	37.6	36.7	37.6	36.7
22.5'	37.0	36.7	37.6	36.5	37.6	36.5	37.6	36.5
25.0'	36.9	36.1	37.6	36.6	37.6	36.6	37.6	36.6
27.5'	36.9	36.1	37.7	37.0	37.7	37.0	37.7	37.0
30.0'	36.9	36.2	37.7	37.1	37.7	37.1	37.7	37.1
32.5'	36.9	36.4	37.7	37.4	37.7	37.4	37.7	37.4
35.0'	36.9	36.5	37.5	37.6	37.5	37.6	37.5	37.6
37.5'	36.9	36.5	37.5	37.6	37.5	37.6	37.5	37.6
40.0'	36.9	36.8	37.5	37.6	37.5	37.6	37.5	37.6
42.5'			37.5	37.7	37.5	37.7	37.5	37.7
45.0'	36.7	36.8	37.5	37.6	37.5	37.6	37.5	37.6
47.5'								
50.0'	36.7	36.8						

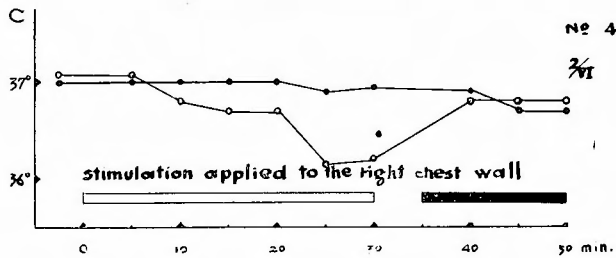
wall (10°) cold stimulus applied on left chest

hot stimulus (45°)

left chest wall (7°) cold stimulus applied on

hot stimulus (45°)

premedication Isomital per oral (0.8 g)  
i. v. injection Mintal (0.1 g)



**Fig. 15** Change in intrapulmonary temperature at thermal stimulation to the chest wall in dog

was no temperature change in the lung on the opposite side.

3) Comments and discussion

As was described above, the reciprocal effects between the oral mucosa and

the cheek skin were studied by stimulating each organ alternately. Also the similar interactions between mucosa of the gastrointestinal tract and the skin was examined in patients who had a fistula. Further in dogs, interactions between the lung and the skin was studied in a same manner.

In the study of the first group a cadaver dog was prepared in order to exclude the transmission of temperature by heat-conduction, from the skin surface whereon the thermal stimulus was applied to the oral mucosa on which the thermo-couple was set. In the living dogs, since the heat applied to the skin surface will partly be brought away by the circulating blood underneath the skin, the factor of heat conduction may become even less.

As seen in Tab. 13 and Fig. 13, increase in the intraoral temperature following the application of hot stimulus upon the cheek skin, was seen in cases No. 1, 6 & 7. By the application of cold stimulus, on the hand, decreases in mucosa temperature was noticed in cases No. 1, 2, 4 & 5. Changes in intraoral temperature for the thermal stimulation to the skin, were seen in greater degree when the cold stimulus was applied than when the hot stimulus was used. This may be partly due to the fact that the intensity of the stimulus given to the normal individuals, was greater in the former than in the later. Because, degrees of deviation in temperature from 37°C (which is the normal body temperature) was greater in the former than in the latter. Also, results of examinations varied considerably according to the season when the examination was made. For example, in cases who were examined during May (cases No. 1~No. 5) cold stimulus easily gave rise to the marked changes in organ temperature, while in cases studied during the period of January and February (cases No. 7 & 8) luminal temperature responded fairly well to the hot stimulus to the skin. Though the room temperature was kept at the relatively constant level, the tonicity of the blood vessel still might be influenced by the change of seasons, consequently the vasomotor responses to the various stimuluses might also varied considerably from in one season to the other.

V. A. LIKHTENSHEIN<sup>41)</sup> carried out a similar kind of experiment and found that these cutaneo-visceral responses became obviously dull during sleep. Then, he divided these responses into two categories; one is the response in which the cerebral cortex is taking a part, and the other is the one in which only the lower level of reflex participates. Further he tried to explain these interrelation between the skin and deeply situated tissue or organ from the viewpoint of the law of conditioned reflex. We could not confirm his view.

In cases No. 9 & 10, the examination was carried out during the fevered period of the patients. In neither of these cases response for the thermal stimulation could be found.

During or right after the period of fever or overheating, the mechanism of body temperature regulation becomes disordered, so that the normal response of the organ to the thermal stimulus is also not to be expected. T. A. SALOVA<sup>42)</sup> tried to demonstrate the stability in the tonicity of the cutaneous arterial net, in



the from of temperature regulating coefficient. According to him, this is fairly stable in a certain skin area and during a certain period, but may vary considerably when body temperature rises. Also, its return to the normal level is much slower than that of body temperature.

When the thermal stimuluses were applied to the oral mucosa, it was followed by the marked changes in the skin temperature of the cheek. Also the burn wound of the oral mucosa gave rise to the decrease in E. S. R. of the cheek skin on the same side.

In the studies on the reciprocal actions between temperature of the skin and that of the gastrointestinal tract using the stomach or intestine fistulas positive data was obtained in few cases. But it must be born in mind that these fistulas were made by surgical procedure and also there previously existed some diseases which needed surgical treatment. Besides these objective changes, also some subjective feelings of temperature at a certain skin area could be provoked more easily by the thermal stimulation to the organ.

Similar temperature response was also found in the lung of the experimental animals by applying the thermal stimulus to the skin of the chest wall. Here again, response occurred more remarkably to the cold stimulus than to hot stimulus than to the hot stimulus. TAKAGI,<sup>46)</sup> through his study on the pressure reflex, also advocated that there might be a reflex between the skin and trachea or pulmonary blood vessels.

Summerlizing the above mentioned results, it was confirmed that thermal stimulation either to the skin or inner organ was responded with the temperature changes in the organ or skin. Thus, through the skin which separates the body content from the external environments, changes in outer world can be transmitted inwards, and also any events occurred inside of the body can be projected outwards.

### CHAPTER III

#### **Electrical skin resistance in various diseases or in some pathological conditions.**

##### 1. Leprosy

It is widely known that there is a disturbance in sweating mechanism in the patients of leprosy. For this reason, they sometimes suffer from the increased body temperature in summer.

Also, the skin areas of the sweating disturbance correspond fairly well to those of the sensory disturbance.

Many investigators<sup>(19)(20)(21)(17)</sup> studied the E. S. R. changes in the patients of leprosy, and they believed that this method was valuable for the objective examination of the sensory disturbance. SERA, on the other hand, performing the similar study, stated that even in the patients of leprosy who had a definite sensory disturbance, no E. S. R. change was noticed unless the sweating disturbance was associated at the same time.

Repeating these experiments, I also had the similar observations as those of SERA. I could further confirm in cases No. 2 & 3 that the existence of an area with dissociated disturbance in sensation and sweating mechanism, was rather a transient one, and both finally became affected as the disease progressed. Thus in the later stage, increase in E. S. R. became also to be found in an area with affected sensation.

Through these findings, we become to know that the sensory function is more vulnerable than the sweating function to the certain noxa applied to the skin. This fact must be considered on the same ground

Tab. 18 Leprosy

No.	Name	age	sex	type
1	M	43	♂	L
2	T	27	♂	L
3	K	46	♂	L
4	K	16	♀	L
5	I	28	♂	L
6	S	72	♂	L

Tab. 19 ESR and sensory disturbance

No. 2						No. 3					
right forearm			left forearm			left chest wall			right chest wall		
date	sensory disturbance	ESR (k $\Omega$ )	date	sensory disturbance	ESR (k $\Omega$ )	date	sensory disturbance	ESR (k $\Omega$ )	date	sensory disturbance	ESR (k $\Omega$ )
6.10	+	840	6.16	-	818	3.18	-	1170	3.18	-	1170
6.30	+	1000	6.30	-	818	6.16	+	860	6.16	-	840
3.7	+	1250	7.7	-	780	6.30	+	840	6.30	-	650
						7.15	+	924	7.15	-	636

with the previously reported data that the highly differentiated complex sensation such as two-point discrimination or position-sense is more likely affected than the simple protopathic sensation in the patients of leprosy (KIMURA, SERA, OKAWA & NAKANO).<sup>48)</sup> Several other experiments were further carried out.

In case No. 5 the right foot, in which the sensation was lost and sweating function remained almost normally, was soaked in hot water (43°C). At the immediately upper point from the water level (paralysed side), and at the corresponding point of the opposite foot (non-paralysed side), E. S. R. was determined (Fig. 17). Rapid decrease in E. S. R. was found on the paralyzed side but almost none on the normal side. Then, the similar measurement of E. S. R. was carried out by soaking the left foot, which is normal side, into the hot water. This time, decrease in E. S. R. was observed bilaterally.

These results are probably due to the fact that in the former experiment, since the sweating function still remained normally in the sensory disturbed area, the application of hot water gave rise to local increase in sweating, but it failed to produce the increase in sweating on the contralateral side because of the lack of remote reflex mechanism through the cutaneous sensation. When the normal foot was warmed, on the other hand, increase in sweating function resulted on both sides through the local and remote reflex mechanisms.<sup>52)51)</sup>

In case No. 4, E. S. R. was determined in the area of loss of sensation (palm

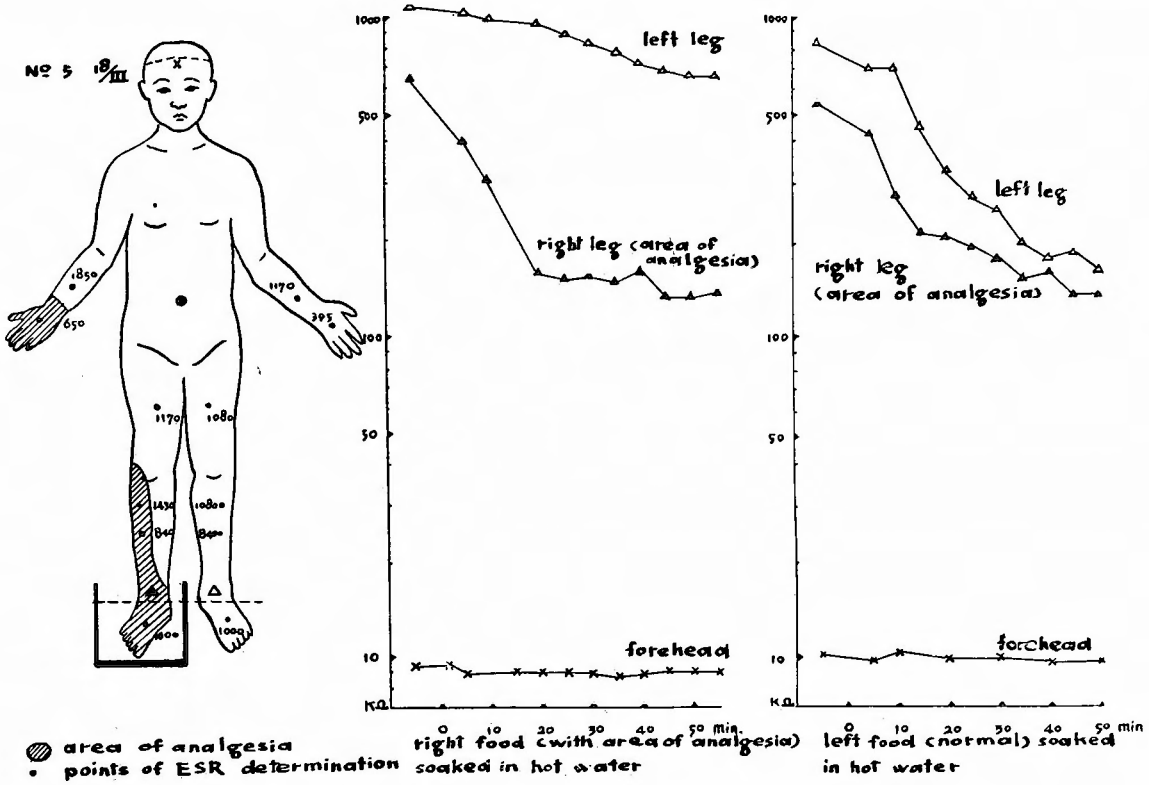


Fig. 17 Sweating through remote reflex mechanism in a patient of leprosy

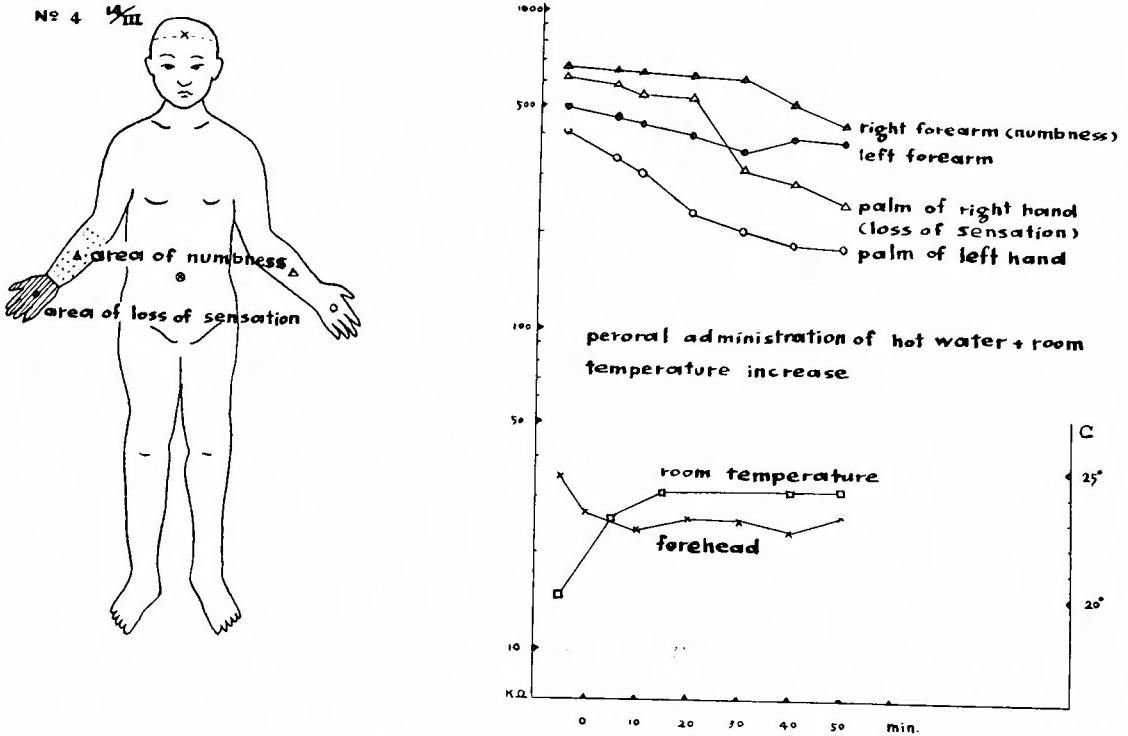


Fig. 18 Sweating in a patient of leprosy

of the right hand), in the slightly paralyzed area (right forearm) and in the normal area (left forearm). Then E. S. R. changes following the oral administration of the hot water (52°C, 300 cc) and following changes in room temperature, were examined. As illustrated in Fig. 18, in the normal skin area E. S. R. decreased reflectively, but nothing happened in the area of loss of sensation and in that of the slightly affected sensation.

In case No. 6, there was found an area of slightly disturbed sensation in the palm of the right hand, and also the patient was complaining about the severe neuralgic pain in the left forearm from 2 days prior to the examination. Hot water (50 C, 200 cc) was given to him per-orally, and the determination of E. S. R. was made on the two aforementioned areas. As shown in Fig. 19, in the

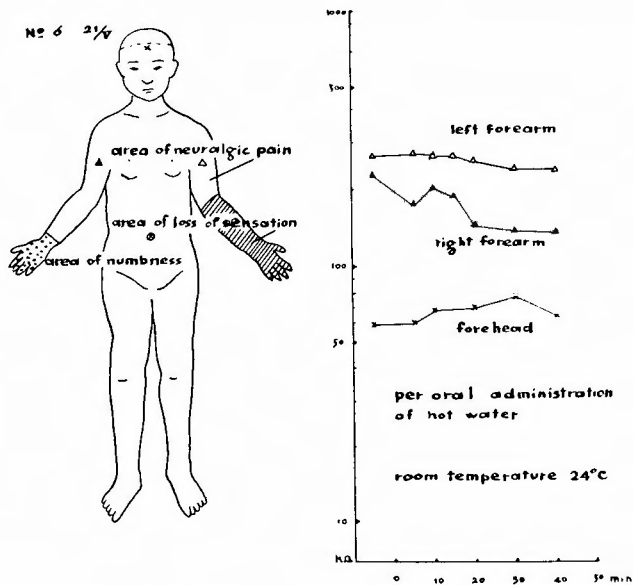


Fig. 19 Sweating in a patient of leprosy

left forearm, in which the acute changes of the peripheral nerve was suspected, no decrease in E. S. R. could be found, while in the right forearm, marked E. S. R. change was noticed.

It is clear from these results that some form of vegetative disturbance, i. e. sweating disturbance, occurs in the patient of leprosy associated with the sensory disturbance, and the former begins to appear later than the latter.<sup>40)</sup> Also it was confirmed from the observation in E. S. R. change that the reflective sweating mechanism becomes dull in the area of sensory disturbance.

## 2. BÜRGER'S disease

BÜRGER'S disease is a chronic vascular disorder which produces the obliterative inflammation in the medium or small sized arteries in the extremities.<sup>53)</sup> SERA<sup>13)</sup> examined E. S. R. in the patients of this and found that E. S. R. was lower in the skin of affected side than that of the normal side.

7 cases of this disease, who had not been treated by surgery and whose lesion was found unilaterally, were prepared for the present study (Tab. 20). In

Tab. 20 Bürger's disease

No.	Name	age sex	affected part	chief complaint symptom	E S R (k $\Omega$ )			temp. °C	date	
					side	A	B			C
1	K	42 ♂	right leg	ache of the leg	right	1050	479	622	19°	53.11.16
					left	1400	422	940		
2	S	48 ♂	left leg	ache of the leg	right	1750	1300	640	20°	54. 2.13
					left	1050	698	666		
3	T	25 ♂	right leg	ache of the leg	right	580	160	125	20°	54. 3.14
					left	880	380	213		
4	T	37 ♂	left leg	ache of the leg	right	435	320	458	23°	54. 4.11
					left	208	165	455		
5	S	35 ♂	left leg	dullness of the leg	right	275	540	275	23°	54. 4.29
					left	230	740	275		
6	S	37 ♂	right leg	dullness of the leg	right	410	106	220	26.5°	54. 7.13
					left	623	372	422		
7	U	30 ♂	right leg	ulcer in toes	right	940	410	131	26.5°	54. 7.13
					left	680	666	230		
8	S	35 ♂	right toes	ulcer in toes and pain				23.5°	53. 2.11	

all patients, E. S. R. was determined at the center of the anterior surface of the thigh (A), at the center of leg just above the tibia (B), and at the center of the back of foot (C). Determination was always made bilaterally and compared each other.

At the point (B), in case No. 1, at (C) in case No. 2 and at (B) in case No. 5, E. S. R. values of the affected side was higher than those of the normal side, and at (C) in case No. 5, no marked difference was seen between both sides. But in all other examinations the affected side always revealed the lower E. S. R. values than those of the normal side.

SERA tried to attribute the decrease in E. S. R. in the affected side to the trophic changes of the skin due to the longstanding insufficiency of blood supply to that area. Besides this, however, reflex mechanism to the sweat gland in a certain area from the affected vascular trees should be counted as an additional factor. In fact, even in the skin areas of the thigh or the upper part of the leg, which were evidently normal either in appearance or with confirmation by angiography, decrease in E. S. R. was definitely observed. This was also true in cases No. 5 & 6 who complained no pain, and the dullness of the leg was the only trouble.

In case No. 8, intravenous injection of 40 mg of benzyl-imidazolin<sup>(54)(55)</sup> was followed by relief of pain and in the marked increase of E. S. R. at the affected part. The effects, however, continued only for one hour and returned to the previous states thereafter. This finding may also suggest that the interruption of the pathological reflex arc originating from the affected blood vessels by benzyl-imidazolin, gave rise to the transient increase in E. S. R. (Fig. 20).

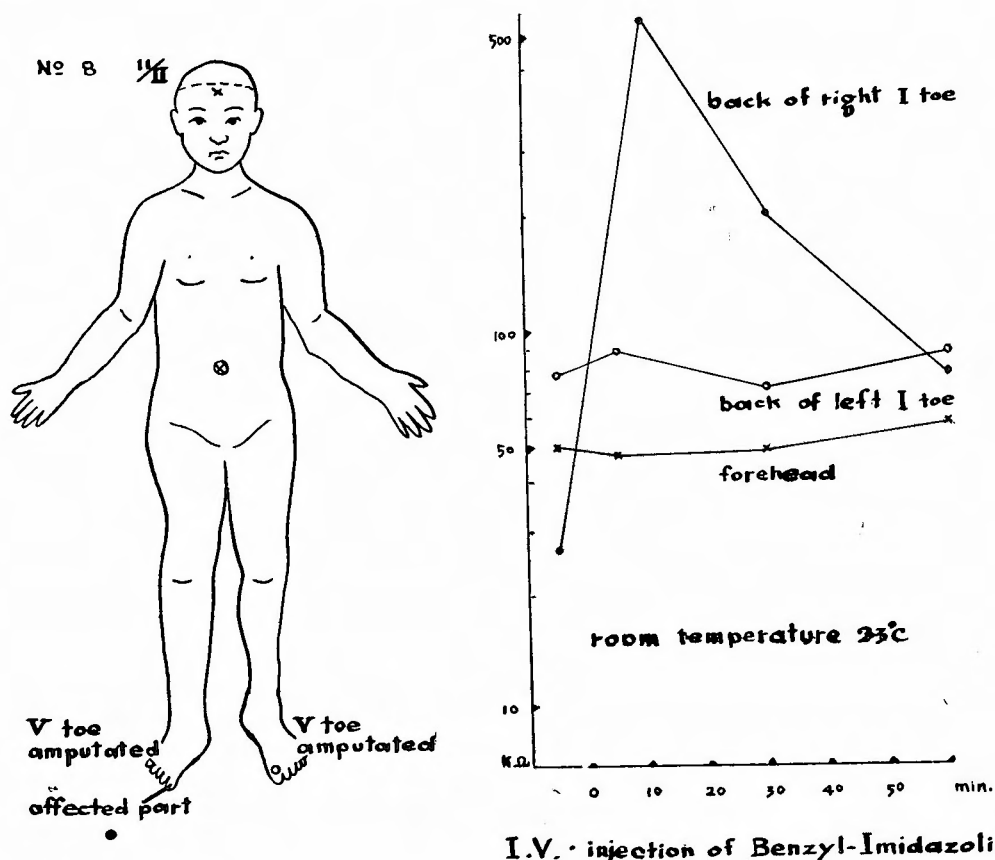


Fig. 20 After benzyl-imidazolin injection to the patient of B rger's disease

### 3. RAYNAUD'S disease and acrocyanosis

These are the functional vascular diseases.

Due to the primary changes in tonicity of the blood vessel, transient or permanent changes in elasticity of the vascular wall and narrowing of the lumen take place secondarily.<sup>52)56)57)58)</sup> Five of these cases who had been never treated by surgery before, were selected. These consisted of 3 cases of acrocyanosis (cases No. 1, 2 & 3) and 2 cases of RAYNAUD'S disease (cases No. 4 & 5). In all

Tab. 21 Functional vascular disease

No.	Name	age	sex	disease	affected part	chief complaint	temp. °C	date
1	H	21	♀	acrocyanosis	distal end of four extremities	cold feeling	19° 53.	1.22
2	K	22	♂	acrocyanosis	left fingers	cyanosis and cold feeling	21° 53.	5.19
3	Y	51	♀	acrocyanosis	distal end of bilateral lower extremities	cold feeling	29.5° 54.	9.14
4	N	28	♂	Raynaud's disease	bilateral fingers and toes	cold feeling and cyanosis	26° 54.	6.23
5	S	38	♀	Raynaud's disease	bilateral fingers and toes	cold feeling and pain	23° 54.11.	2

cases, tip of the fingers or toes was felt cold and looked pale or cyanotic in winter time. In the latter two cases pain was provoked reflectively in the exposure to cold stimuluses.

In case No. 2 cyanosis was found in unilateral hand and E. S. R. values at the finger-tips were equal on both sides. But the E. S. R. in the areas either affected or normal, was very unstable and varied very easily by the changes in

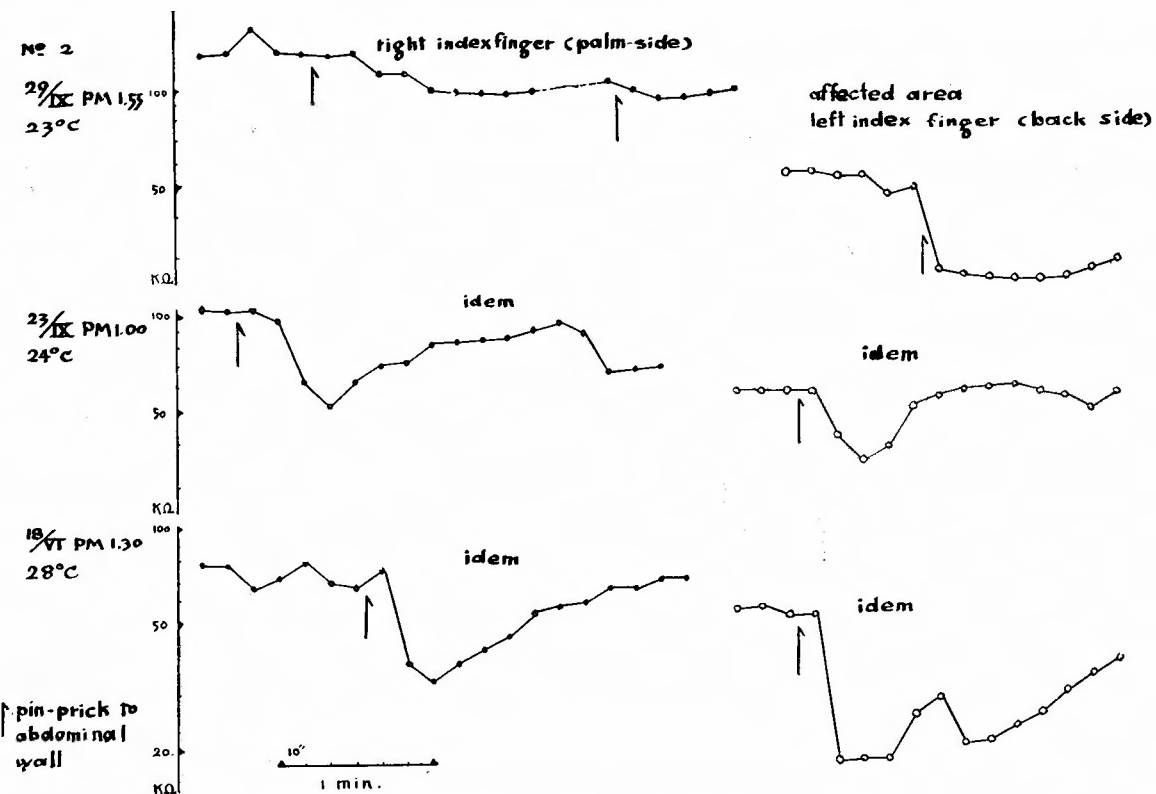


Fig. 21 Change in ESR in the patient of acrocyanosis

external environment. For example, when the room temperature was 24°C or more, pin-prick stimulation on the abdominal wall was followed by the transient decrease in E. S. R. at the palm of the bilateral hands, while at the 23°C of room temperature, same stimulus resulted in no response on the normal side. On the affected side, on the other hand, marked decrease in E. S. R. appeared either in palm or in back of the hand (Fig. 21).

In case No. 4 (RAYNAUD'S disease), when the patient's right hand was put into the cold water (10°C), E. S. R. decreased at the back of the bilateral 1st

Tab. 22

No.	point of ESR determination	before (kΩ)	2 min.	5 min.	10 min.
4	at the nail-base of right 1st toe	96	96	62.8	58
5	at the nail-base of right 1st toe	154	143	112	98

toes. In case No. 5 (RAYNAUD'S disease) the same condition sometimes (once in every three times tests) gave rise to pain of moderate degree and the decrease in E. S. R. at the toes of the right foot. In both cases skin discoloration was not so marked (Tab. 22).

In all three cases of acrocyanosis, these changes could not be found. In one case of acrocyanosis (case No. 1) kallikrein was injected for therapeutic pur-

the patient of acrocyanosis.

№ 1

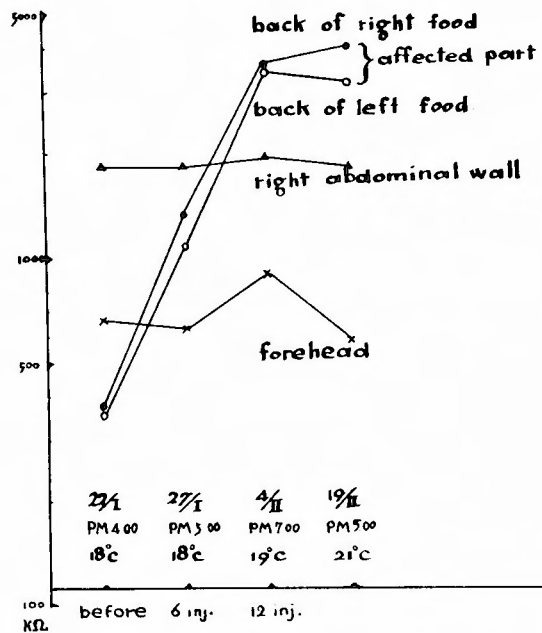


Fig. 22 After Kallikrein injection to the patient of acrocyanosis

pose. After an injection, cold feeling in the back of the foot subsided considerably, and E. S. R. in that area also increased markedly (Fig. 22).

#### 4. Neurological diseases

Tab. 23 Diseases of nervous system

No.	Name	age sex	disease	location · symptom	temp. °C	date
1	T	30 ♀	Quincke's edema	right half of face · pain	20°	54. 2. 5
2	T	23 ♀	cerebral embolism	right hemihyesthesia · pain	24°	54. 4. 11
3	T	36 ♀	trigeminal neuralgia	right half of face · pain	23°	53. 9. 16
4	S	79 ♂	trigeminal neuralgia	right half of face · pain	23°	55. 10. 10
5	T	26 ♂	myelitis	area of anhidrosis at C <sub>6</sub> ~Th <sub>7</sub> and sensory level at Th <sub>7</sub>	20°	53. 2. 11
6	S	63 ♂	neurinoma	right tibial nerve · tenderness	23°	54. 6. 20
7	N	43 ♂	ragotonia	headache, vomiting etc.	31°	54. 8. 14



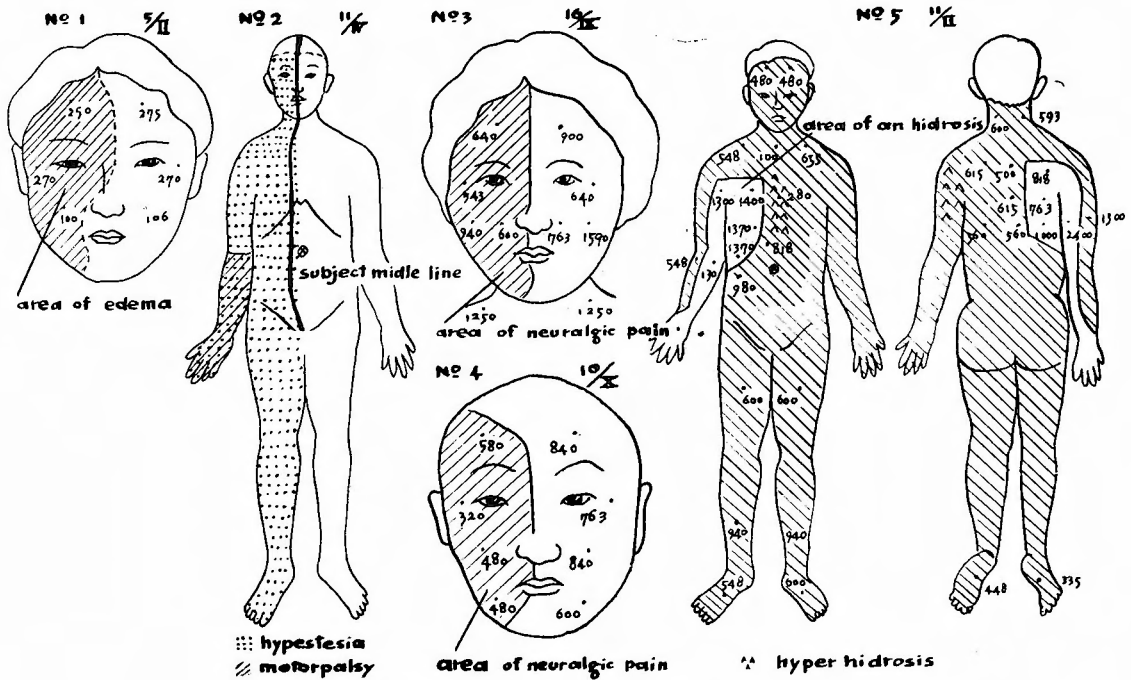


Fig. 23 ESR in various diseases of nervous tissue

E. S. R. determination was carried out in the patients suffering from the central or peripheral nervous system, as illustrated in Tab. 23 & Fig. 23.

Case No. 1. QUINCK'S edema. Edema appeared 2 or 3 times an year in the right half of the face. Each time it continued for 3 days and then subsided. During the episode, E. S. R. was measured either on edema side or normal side. There was found no difference between two sides.

Case No. 2. Hemi-hypesthesia due to the cerebral embolism. This conditions occurred 7 days after the operation for the glomic tumor along the left carotid artery. Increase in body temperature and in E. S. R. was seen in the affected half of the body. Subjective determination of body-midline was deviated towards the affected side due to the disturbance of the initial local sign(KIMURA<sup>33)</sup>).

Cases No. 3 & 4. Trigeminal neuralgia. Both of these cases had right hemi-facial pain, and it was intractable during the episode. In both patients marked decrease in E. S. R. was found in the affected side of the face.

Case No. 5. Myelitis. This patient had the low sensory level below Th<sub>7</sub>. Also at the level between C<sub>7</sub> and Th<sub>7</sub> there was found a distinct areas of anhidrosis. Corresponding to this zone of anhidrosis, marked increase in E. S. R. was found.

Case No. 6. Neurinoma. This patient's chief complaint was a diffuse swelling in the posterior part of the right ankle and tenderness of that area. He had been having the dull ache and tenderness on pressure for about 40 years, but recently pain became sharper and of shooting nature. Also he began to limp.

In the lower portion of the right leg, there was area of hyperesthesia in which the marked decrease in E. S. R. was observed. A neurinoma of the right tibial

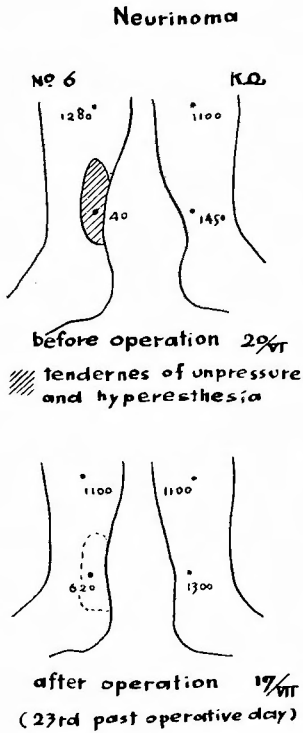


Fig. 24 Neurinoma

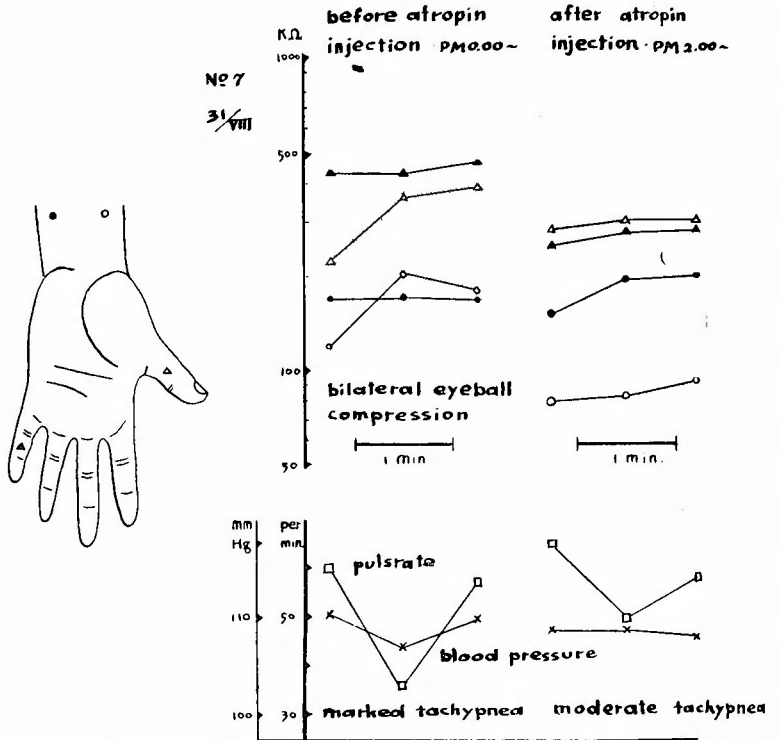


Fig. 25 Vagotonia

nerve was removed operatively. After the surgery all discomforts disappeared. The area of decreased E. S. R. also completely disappeared (Fig. 24).

Case No. 7. Vagotonia. 19 years ago he noticed the black stool. It continued for 3 months. He did not noticed black stool thereafter but he began to have headache, abdominal pain or vomiting quite often, especially when he was tired. X-ray examinations of the stomach were negative except the finding of gastroptosis. ASCHNER's test was three positive, and respiratory bradycardia was positive, too. E. S. R. was determined before, during and after the ASCHNER's test (bilateral eye-ball compression for 50 seconds) at the radial side of the left forearm, at the flexor side of the left thumb and at the ulnar side of the left forearm. At former two points a positive change in E. S. R. was noticed by the bulbar compression, but at the latter one it was negative. By injecting atropine, these changes were no more observed in anywhere (Fig. 25).

Summerizing these, under the irritated or paralyzed conditions of nervous system, if the sweating mechanism was activated (in case No. 3, 4 & 6), values of E. S. R. decreased, while if inhibited they increased. This was true no matter where the lesions situated. Either centrally or peripherally. Also these changes

were more definitely noticed in the localized areas, in the chronic disease than in the acute or transient one.

5. Skin graft

Two patients who had a fairly large skin graft, were examined.

Case No. 1 suffered from a large carbuncle in the center of the chest wall. After the granulation developed, 10 cm×8 cm of skin piece was grafted ac-

Tab. 24 Skin graft

No.	Name	age·sex	disease	location	E S R (kΩ)		temp. °C	date
					skin graft	surrounding		
1	N	60 ♀	carbunculus	anterior chest wall	381	381	21°	53. 3.24
2	H	45 ♀	burn	left leg	861	842	26°	54. 6.20

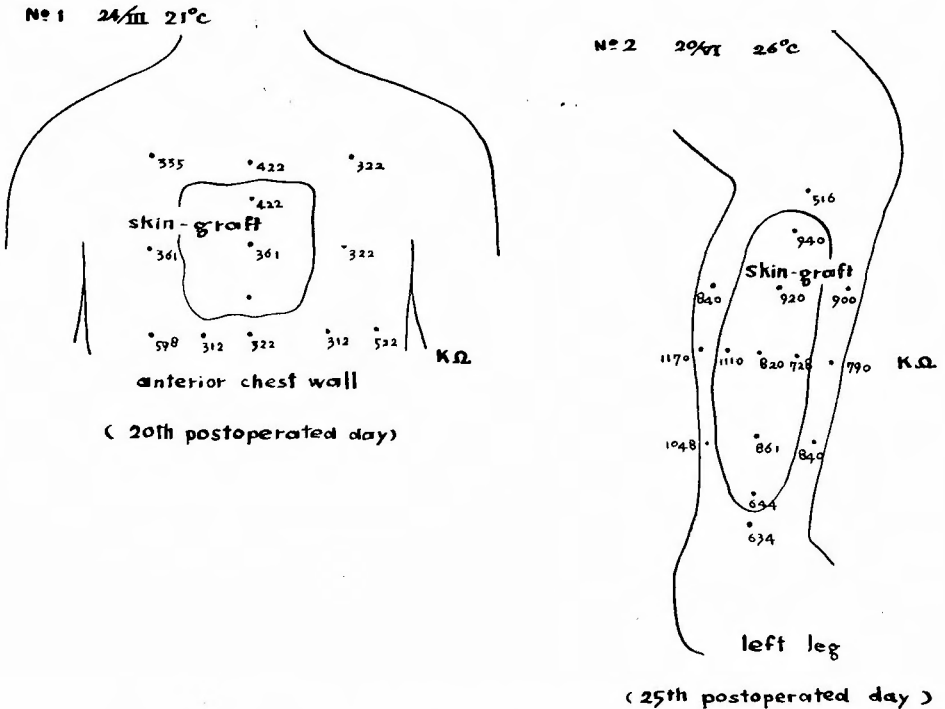


Fig. 26 E S R in skin graft

ording to the THIERSCHE'S method. On the 10th postoperative day E. S. R. on the skin graft was higher compared to that of the surrounding skin area. On the 20th postoperative day, however, no difference in E. S. R. was noticed between them.

Case No. 2 had a burn of grade II. & III. in left leg. At the time when the wound became clean and covered with normal granulation, autotransplantation of skin was carried out according to the THIERSCHE'S method. On the the 25th postoperative day there was observed no change in E. S. R. between on the skin graft and on the adjacent skin area.

SERA made E. S. R. determinations on the regenerated epidermis at the burn wound in chronological way. He found that after 1 month E. S. R. value on the wound in the palm of the hand was still lower on the affected side, but there was no difference in the back of the hand between two sides. 2 months later E. S. R. value returned to normal and no significant change was found anywhere. He supposed that decrease in E. S. R. might be due to the thinness of newly formed epidermis.

In my study, however, E. S. R. on the skin graft returned to the normal value within 25 days. This indicates that the sweat gland in the graft is again functioning normally at this period (Tab. 24 & Fig. 26).

### 6. Thrombophlebitis

3 cases of thrombophlebitis were prepared for E. S. R. determination.

Case No. 1 had the repeated intravenous injection for his lumbago. After the approximately 10 times of injection, the site of injection gradually became swollen and tender. As the time elapsed, the vein became palpable as a indurated string. On examination, E. S. R. value was lower in the whole right

Tab. 25 Thrombophlebitis

No.	Name	age·sex	disease	location	temp. °C	date
1	O	23 ♂	thrombophlebitis	right cubital vein	23°	54. 4.29
2	I	64 ♂	thrombophlebitis	left femoral vein	23°	53. 4.16
3	K	45 ♂	thrombophlebitis	right major saphenal vein	25°	55. 6. 1

upper extremity than that on the left side. Particularly, however, decrease in E. S. R. was most significantly found on the point of the affected vein.

Case No. 2 had thrombophlebitis of the left femoral vein. Indurated string was felt in the left subinguinal area. E. S. R. value was lower in the upper third

Tab. 26 ESR in patient of thrombophlebitis

No.	Name	side	E S R (κn)			
			forearm (distal 3rd)	foearm (proximal 3rd)	upperarm (middle 3rd)	
1	K	right	69	45 (on lesion)	78	
		left	78	78	80	
2	I		thigh (upper 3rd)	thigh (middle 3rd)	thigh (lower 3rd)	
		right	522	548	570	
	left	361 (on lesion)	422	600		
	one year later	right	540	644	597	
		left	579 (on lesion)	640	585	
3	K		leg (lower 3rd)	leg (middle 3rd)	leg (upper 3rd)	thigh (middle)
		right	548	522(on lesion)	570	882
		left	600	600	600	822

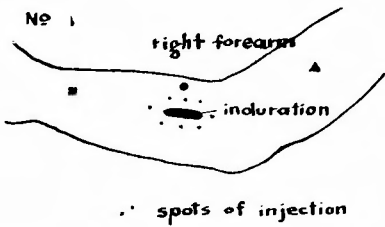
of the thigh compared to that of the middle or lower third. That was also lower compared to E. S. R. values on the opposite side. Injections of benzylimidazolin were repeated to him for a long period. After one year and half, the induration disappeared and there was found no difference in E. S. R. between two thighs.

Case No. 3 had suffered long from varicosis in the bilateral legs. All suddenly he began to have the pain and swelling in the middle third of the right leg. By the intensive use of antibiotics, these symptoms subsided soon. Still, however, E. S. R. values in the whole right leg were lower than that of the left leg. E. S. R. value in the right thigh was also slightly lower than on the opposite side. There was no E. S. R. difference between two feet.

In all these three cases E. S. R. of the affected side revealed always lower values compared to the normal side. Among all, the lowest value of E. S. R. was seen around the site of lesion.

These may suggest that the abnormal stimuluses from the affected vein probably inhibit the sweating mechanism in the corresponding skin area reflectively (Tab. 26).

In case No. 1 block of the lesion was carried out by injecting 20 cc of 0.5 % novocain plus 0.5 cc of 2.5% hexamethonium, around and to the base of the affected vein. Also, the same procedure was carried out at the corresponding



novocain injection to the corresponding point in the right forearm

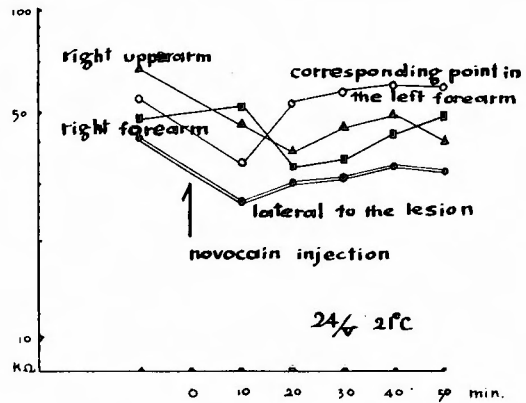
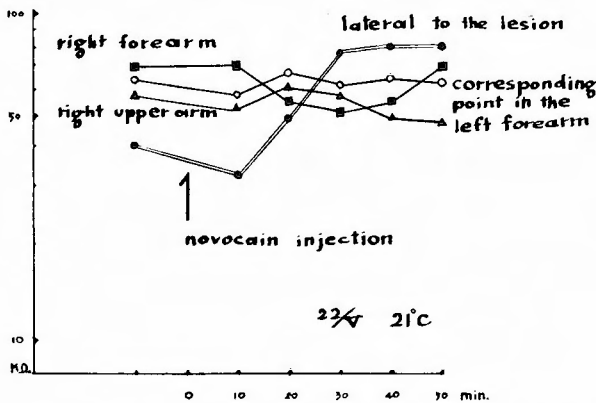


Fig. 27 Change in ESR at the novocain block

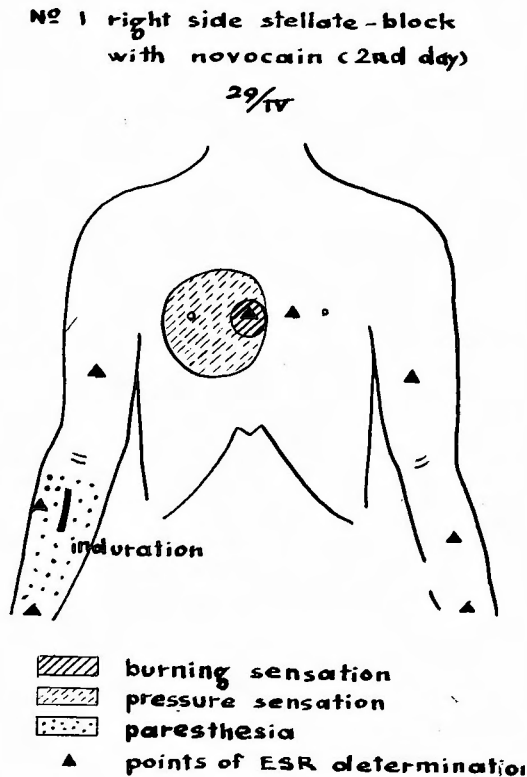
area on the normal side. In the former, marked increase in E. S. R. appeared at the adjacent skin area to the block from 20 minutes after the injection, and skin temperature rose slightly. In the latter, the similar increase in E. S. R. and skin temperature were also found, but they were definitely less obvious.

It could be assumed that the abnormal impulses arising from the affected vein was successfully blocked by the procedure.

Further, for this patient the stellate ganglion block with novocain was carried out on the right side. 2 hours after the injection, the patient began to have a sore spot in the right chest wall and the pressure feeling around it. At the same time he became to have severe episodes of coughing which lasted for 4 days.

**Tab. 27** Change in ESR at stellate ganglion block

No.	Name	location		before	2 days later	4 days later	10 days later
1	K	ESR (k $\Omega$ )	right chest wall	59.3	78.0	69.8	56.0
			left chest wall	53.8	30.6	21.8	46.8
		skin temp. °C	right chest wall	29.3	31.0	28.1	30.3
			left chest wall	29.4	32.7	28.5	30.5
		room temperature		20	22	22.5	23



**Fig. 28** Patient of thrombophlebitis.

On the 4th day after the ganglion block coughing and pain on the chest wall disappeared almost completely, still there was found increase in E. S. R. and skin temperature in that area. These abnormalities were no more observable on the 10th day after the block (Tab. 27 & Fig. 28).

### SUMMARY

1. Using the electric dermometer and thermo-couple thermometer, electrical skin resistance, skin temperature and temperature of the organs were measured both in normal and pathological cases.

2. In diseases of the pharynx, thoracic organs and the urogenital organs, there were found the areas of decreased E. S. R. at the certain skin area. This was probably based on the viscerocutaneous reflex.

3. These areas with decreased E. S. R. corresponded very often to the point to which pain of the organ radiated, or the points in the HEAD's dermatom.

4. Decrease in E. S. R. in the localized skin area was more likely seen in the chronic stage of disease than in the acute stage.

5. Thermal stimulation to the skin surface, gave rise to temperature change in the corresponding organ. It was probably due to the cutaneo-visceral reflex mechanism.

6. Thermal stimulation to the organ provoked the subjective temperature feeling or actual temperature change in the corresponding skin area.

7. In the patients of leprosy, a dissociation in sensory function and sweating mechanism in the same skin area, was confirmed from the viewpoint of E. S. R.

8. Decrease in E. S. R. observed in the patients of BÜRGER'S disease, was attributable to the reflex mechanism from the affected vascular trees as well as to the trophic changes of skin due to the longstanding insufficiency of blood supply.

9. There were found abnormalities in E. S. R. in the patients either of the central or peripheral nervous system.

10. 20-25 days after skin transplantation, there was found no marked difference in E. S. R. between on the grafted skin and on the surrounding skin area.

11. In the patients of thrombophlebitis, decrease in E. S. R. was found at the skin area surrounding the lesion. This was probably due to the abnormal reflex mechanism from the affected vein.

I would like to express my deep gratitude to Prof. Dr. YASUMASA AOYAGI for his guidance and warm encouragement. Many thanks to Dr. M. NISHIURA in the Department of Dermatology and to Dr. S. SASAGAWA in the Department of Hygiene for giving chances and facilities to my study.

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## 和 文 抄 録

# 皮膚電気抵抗と皮温の測定による内臓・皮膚相互作用にかんする臨床的および実験的研究

京都大学医学部外科学教室 第2講座 (指導 : 青柳安誠教授)

中 野 進

生体は皮膚によつて外部環境と境され独立しているが、この皮膚を観察することにより、内臓・皮膚反射を通して、内部臓器の異変をある程度推察できる。また外部環境はこの皮膚に刺激をあたえることにより内臓に種々の影響をおよぼしうる。これらの皮膚・内臓(外界・内界)相互作用を、皮膚電気抵抗と皮温の測定によつて検討し、つぎの結果をえた。

1) 咽頭、胸部内臓、泌尿器官の疾患時には、関連皮膚部分に抵抗減弱を証明したが、これは内臓・皮膚反射によるものと考えられる。これらの部分は圧痛点、知覚過敏帯などの部分と一致することが多い。また抵抗減弱は急性期の場合より、限局性、慢性期により明確である。

2) 皮膚温度刺激によつて、相当した内臓温度に変化をおこしうる。また内臓内腔に温度刺激を加えると

皮膚に温度感覚や皮温変化をおこすことができる。これらは反射性的変化である。

3) 癩患者において皮膚抵抗測定することによつて、発汗機能の障害と知覚障害の分離を証明した。

4) Bürger氏病患者の抵抗減弱は、皮膚栄養障害によるもののほか、罹患血管からの病的刺激によるものがある。

5) 末梢、中枢神経障害、機能性血管疾患時に皮膚抵抗に異常があらわれる。

6) 広範囲皮膚移植部分で、20日目ごろには周囲皮膚とのあいだに抵抗の差をみとめない。

7) 血栓静脈炎患者において、病変部皮膚には抵抗減弱をみるが、これは血管病巣よりの異常反射によるもので、ノボカインにより封鎖することができる。