# 3rd SESSION: THERMOGRAPHY IN VASCULAR DISEASE

## Thermography in the study of 'varices

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**SUMMARY. Fifty patients with varices in the lower extremities were studied; in 8 the varices were postphlebitic (4 males and 4 females; 6 cases in the left side, 1 in the right leg, 1 bilateral); in 42 the varices are essential (50% in the right side, 80% in females, age 18-69). The thermographic picture in the internal saphena system, external saphena system and fourth system, communicants and collaterals was analysed. Also the abdominal venous system in the postphlehitic cases and the complications (ulcus, varicophlebitis, hypodermatitis) that were present in 50% of the patients. The indications of thermography in the study of varices are marked (knowledge of extension, therapeutic response, epidermal iatrogenic changes, mimetism of the course for the surgeon). Also the advantages of thermography (simplicity, innocuousness, repeatibility, objectivity, possibility of dynamic studies, possibility of knowledge of the disease without the introduction of devices or irritative response of other procedures).**

**Key words: thermography, varices.**

### INTRODUCTION

In spite of the great development of thermography during the last ten years, interest shown in it in the different fields has not been uniform and relatively little attention has been paid to venous pathology. In fact, a bibliographical search has revealed very few references and few writers (Resenberg, Lloyd-Williams, Ghys and the slight references of Nakanishi and Lamarque). We are aware also of the attention others have paid to the subject although not for publication.

Our work explains the application of thermography to the study of varices, based on the analysis of clinical results in 50 cases. The first stage is devoted to an approach to the problem, with the intention of passing on to a second stage, that of determining the response to dynamic tests for venous insufficiency.

### MATERIAL AND METHODS

A study was carried out on 50 patients with varices in the lower extremities, 8 of which were of postphlebitic etiology and 42 cases classified as idiopathic.

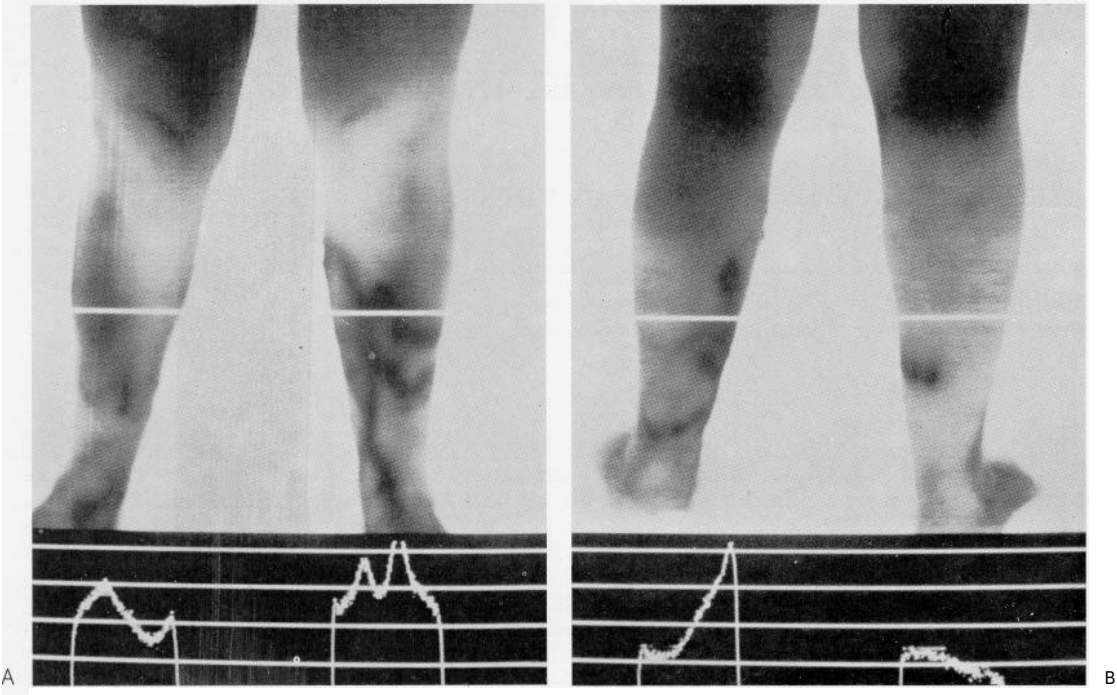
Distribution by sexes for both groups is given in Table I.

**Tab. I. Distribution by sexes in 50 cases of varices.**

| | *Postphlebitic* | *Essential* | *Total* |
|---|---|---|---|
| **Males** | **8** | *4* | **12** |
| Females | **34** | **4** | **38** |
| Total | **42** | **s** | **50** |

The 8 postphlebitic cases are aged between 31 and 78 years, with an average of 47; 4 of the cases were aged between 42 and 46. The ages of the 42 essential cases oscillated between 19 and 68, with an average of 42 (Table II). Table III shows the lateral distribution.

In the study of the lower extremities the following projections have been used: anterior, posterior, medial, lateral; it was possible to obtain in a photogram the lateral out face of one extremity and the medial of the other with one foot forward from the other



A B

Fig. 1 A-B. Anterior view. (A) Varicous tract of the saphena magna system (with collaterals). Posterior view. (B) The linear analysis, or thermal profile, shows a 3 °C difference.

Tab. 1.1. Age **distribution in 50 cases of varices.**

| Age | *Essential* | *Postpklebitic* |
|---|---|---|
| under 20 | 1 | - |
| 20-29 | 7 | - |
| 30-39 | 8 | 2 |
| 40-49 | 13 | 4 |
| 50-59 | 6 | 1 |
| GO-69 | 7 | 0 |
| 70-..... | 0 | 1 |
| Total | 42 | 8 |

Tab. III. **Distribution by localization in 50 cases of varices.**

| | *Right* | *Left* | *Bilateral* |
|---|---|---|---|
| Postphlebitic | 1 | 6 | 1 |
| Essential | 21 | 13 | 8 |
| Total | 22 | 19 | 9 |

(Figs. 1 and 6). For the analysis of the abdominal wall circulation, use has been made of frontal projection and both obliques.

In some cases an analysis was made of the changes occuring after the collapse.

**RESULTS**

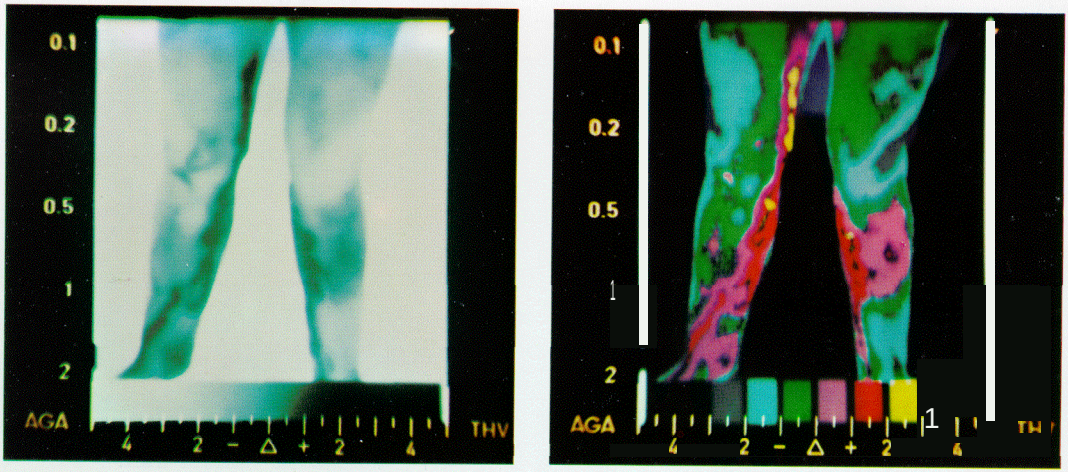
The lower extremities are shown in the normal thermogram as cold zones, except at the level of the popliteal, caval and inguinal region where there is slight physiological hyperthermia due to an increase in infrared reflexion. In the thigh and leg and varying greatly from one person to another, one can see trajections of hyperthermia of some two degrees, linear in form, and which correspond with the superficial venous system.

The abdominal wall in normal conditions does not show vascular trajections in young individuals; on the other hand, in globular abdomens some trajections can be seen in both voids and suprapubic region.

In the *essential varices* the findings can be thus synthesized:

Marked lineal hyperthermia in correlation with the dilated venous trajection, the gradient of which varies from 3 to 6 °C with respect to the other member (Figs. 1 and 2).

In the majority of cases, the system affected is that of the internal saphena (Figs. 1




A B

Fig. 2 A-B. Frontal view. (A) Bilateral varicous tract of the saphena magna system. In colour (B) can be judged a gradient of around 5 °C.

and 2). The external saphena is affected in approximately 10% of the cases. Both systems are affected very infrequently (Fig. 6). We have seen the fourth system affected in one case (Fig. 3).

In 15 to 20% of the cases one observes the existence of communicants (Fig. 5).

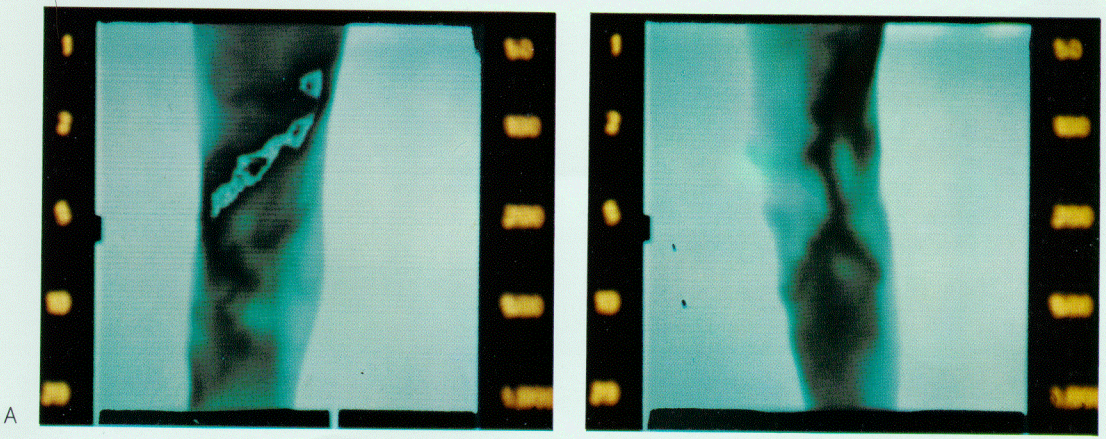
Also, the existence of collaterals can be clearly seen (Figs. 1 and 5).

The most frequent complication seen in thermography is varicophlebitis (Fig. 4) which thermographically is going to present a stain of hyperthermia around the presumed varicose trajection, and which constitutes useful information for the doctor for the delimitation of the phlebitic area and for the appraisal of the evolution.

The ulcerous complication always has its correspondence in the thermographic recording (Figs. 5 and 7) and is reliable for estimating the involution.

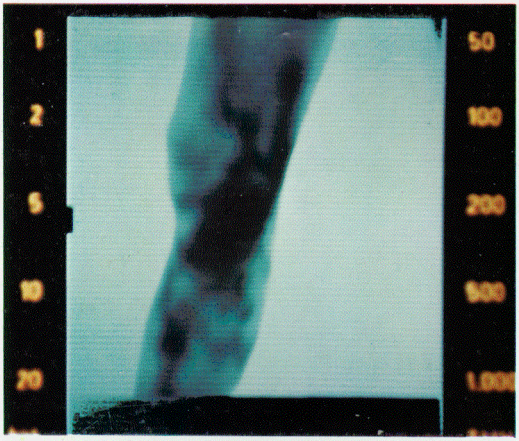
Other complications such as oedema, eczema and hypodermitis have not sufficient thermographic meaning.

In the *postphlebitic varices* the thermographic picture in the lower extremities is similar to idiopathic varices. On the other hand the thermographic signs in the anterior abdominal



A B

Fig. 3 A-B. Disorder of the 4th system.



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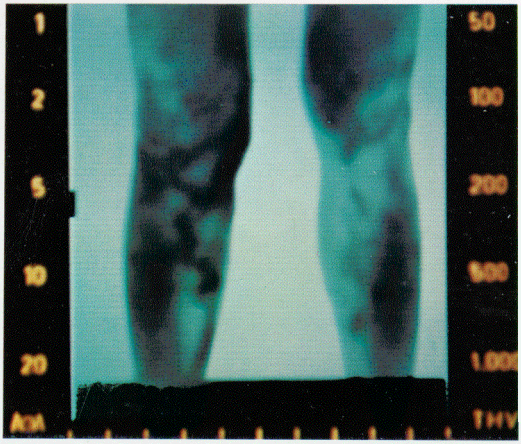

B

Fig. 4 A-B. Varicophlebitis pattern with hyperthermie around the varicous tract.

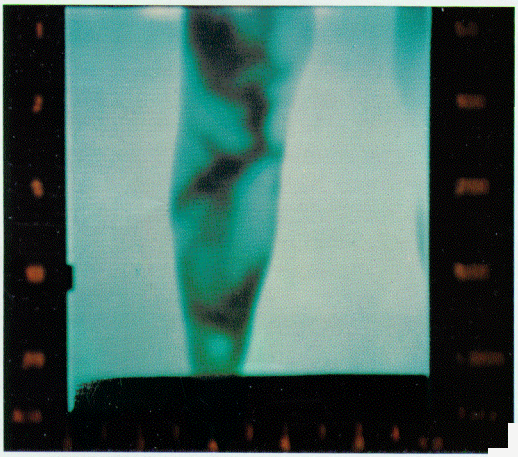

Fig. 5. Ulcus cruris pattern made evident in the thermography, as a complication of the varicous lesions.

wall are important (Fig. 6). When the obstacle in the deep venous circulation remains, the internal saphena being insufficient. the venous flow opts For the external iliac circum flex (to drain the flow in the lumbar veins. Fig. 8), for the abdominal subcutaneous (to end in the mammary vein) or for the supra-pubic vein of complementary flow (that runs to the contralateral external pudenda) (Figs. 7 and 9).

## DISCUSSION

The only complexity in the thermographic study of varices arises in some cases from to the need for the numerous projections which arc required for the complete analysis of each cast. But it has its compensation in that it is innocuous.

From an analysis of the results the indications summarized in table IV have been deduced.

In practice, contraindications do not exist and the advantages are schematically shown in Table V.

Tab. 1V. **Indications of thermography in venous pathology.**

| |
|---|
| * Knowledge: of the extension of the disease |
| * Analysis of the complications (varicophlebitis, ulcers, epidcrmic alterations). |
| * Study of the response t0 treatment |
| * Knowledge of epidermic and iatrogenic alterations |
| * Exclusion of the postphlebitic varices in the absence of the increase of vascularization at the level of the tributary system of the internal iliac with its abdominal vascular manifestations. |
| * Indication and delimitation of the map of the skin for the surgeon. |

Tab. V. **Advantages of thermography in venous pathology.**

| |
|---|
| simplicity |
| innocuousness |
| repeatability |
| obiectibilitv |
| possibility “of dynamic studies |
| possibility of knowledge of the disease without the introduction of devices or irritative response of other procedures. |

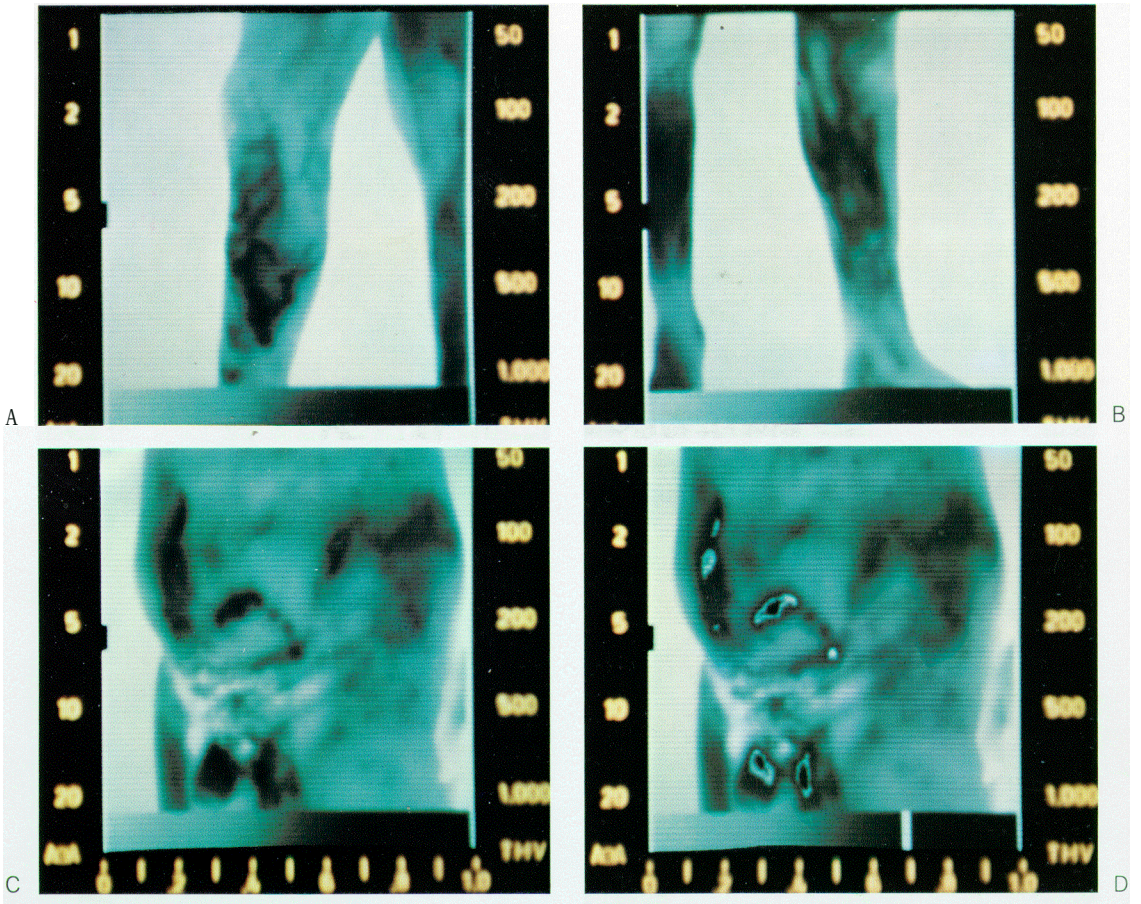


Fig. 6 A-B-C-D. Postphlebitic varices on the left lower limb (A-B) (affecting both saphenous systems) with abdominal extension (C-D).

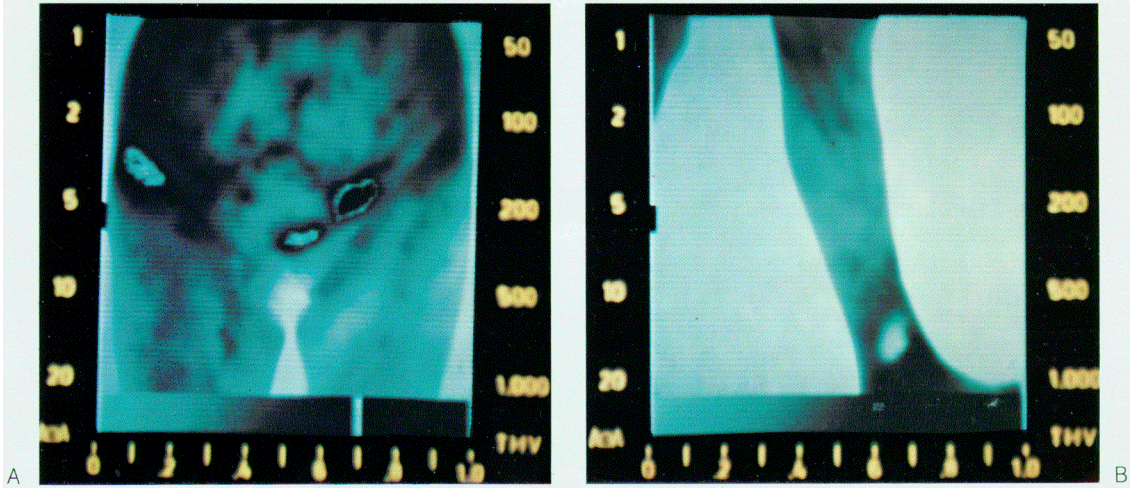


Fig. 7 A-B. Suprapubic varicous disease (an ulcus over the ankle can be seen).

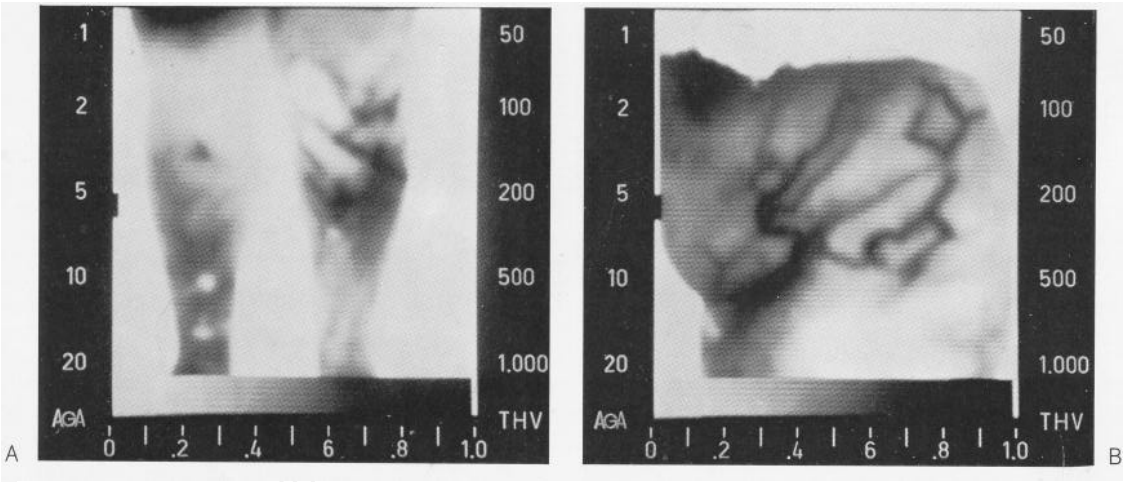


Fig. 8 A-B. Postphlebitic varices on left lower limb (A) affecting the external iliac circumflex vein (vena circumflexa ilium superficialis) (B).

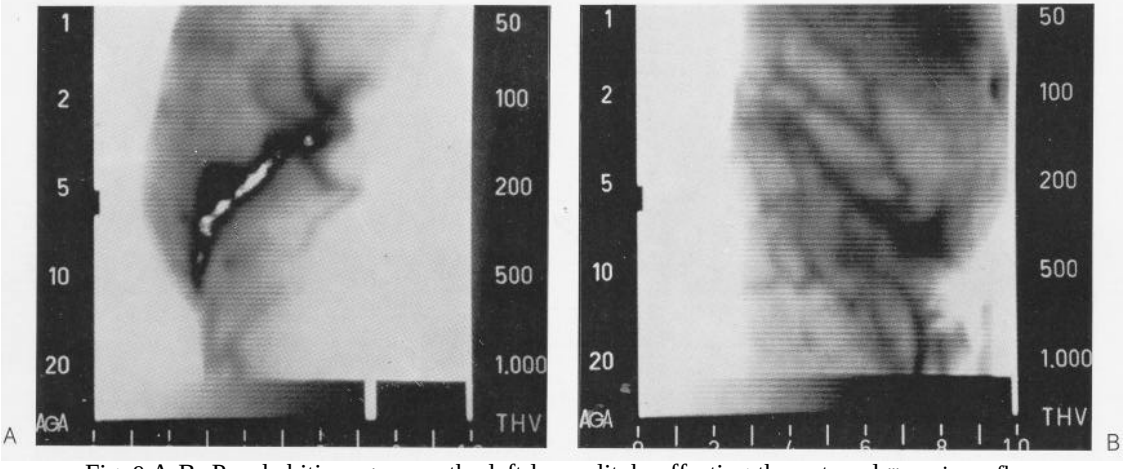


Fig. 9 A-B. Posphebitic varices on the left lower litnh, affecting the external iliac circumflex vein (A) through the suprapuhic vein with complementary circulation from the contralateral vena pudenda externa (B).

Among the inconveniences one must bear in mind the errors which can be produced by the ointments which cover the skin and the time taken for the exploration for a complete functional study. In addition time is required for the adaptation of the patient once footwear, stockings and bandages have been removed.

In a second stage, an attempt has been made to study a possible thermo-phlebography correlation with the intention of showing those situations where thermography can be used alone. In this second stage a study is also carried out on the response to dynamic tests (posture changes, responses to cold) which can increase the value of the test.

This present work has as its objective, to analyse the findings of the spontaneous signs in the two main types of varices, and, in particular, to show the whole of an abdominal study in postphlebitic cases.

# Dynamic telethermography in diagnosis of acute and postoperative deep vein thrombosis

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**SUMMARY. An evaluation was made on the use of thermography for screening of postoperative thrombosis and in diagnosis of suspected acute thrombosis. The study was made on 616 legs and 137 legs respectively. The thermographic criteria for diagnosis of DVT was described and the advantage of posterior use in interpretation is stressed.**

**Key words: thermography, screening, diagnosis, acute and postoperative thrombi.**

Recently it has been well established that there is poor agreement between the clinical and objective diagnosis of deep vein thrombosis. In consequence it is important to use an objective diagnostic method. Phlebography has been most commonly used. This method, however, may involve the risk of complications from contrast medium and may sometimes be cumbersone to both patient and doctor [1, 2, 3]. In the search for other preferable non-invasive and simples methods one old clinical sign has been reestablished. Delayed cooling caused an increased temperature in the thrombosed leg as pointed out by Pilcher in 1939 [4]. This can obviously be subclinical and thus not possible to detect by palpation. Thermography is more sensitive and there are findings which in theory suggest the possible use of thermography. The blood flow is forced superficially by the thrombosis giving a derivated flow on phlebography [5]. There is increased arterial blood flow in the skin of the thrombosed leg, at rest which can be measured by plethysmography [6]. The inflammatory reaction around the thrombotic process also gives rise to an increased temperature. Thus, thermography is the logical technique for obtaining information about this increased temperature, as proposed by Cooke and Pilcher [7, 8]. The purpose of this study has been to compare thermography and phlebography in acute deep vein thrombosis and to compare thermography and $^{125}$1-fibrinogen test in the screening of postoperative thrombosis.

## MATERIAL AND METHODS

Patients with a suspected deep venous thrombosis were investigated with thermography as well as phlebography. Clinical signs which gave rise to suspicion of deep venous thrombosis were calf tenderness, Homan's sign, oedema or temperature and in a few cases unexpected postoperative fever or pulmonary embolism. The two investigations were made within a short time of each other (mean difference of 0,7 days). In 137 patients (72 male, 65 female; 16-86 years of age << mean age 60 >> both phlebography and thermography were made. Postoperative screenings of deep venous thrombosis were made in 616 legs in 308 patients. Thermography was compared with $^{125}$I-fibrinogen test. The patients (general and orthopaedic surgery) were screened for one week for the presence of deep venous thrombosis. 20% increase in fibrinogen uptake on two consecutive investigations was used as the criterion for diagnosis of thrombosis. The principles of this technique do not differ from these described by other investigators. The comparison between thermography and I-fibrinogen test was based only on the uptake curves and thermograms without regard to clinical findings.

Thermography was performed using AGA's

**Tab. I. Comparison between thermography and phlebography.** The **agreement is 89.0%. The figure within brackets represents uncertain cases with only minimal contrast defects on the phlebograms.**

| | *positive phlebography* | *negative phlebography* |
|---|---|---|
| positive thermography | 86 | 2 |
| negative thermography | 4 (8) | 37 |

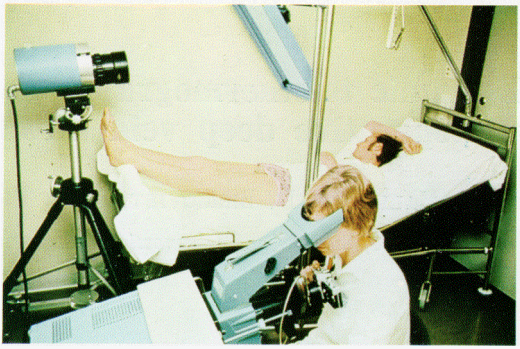


Fig. 1. Thermographic set-up with an aluminium oxide mirror, and the patient with the legs elevated about 15".

Thermovision 680 Medical System. The thermographic picture was photographed either as a grey tone picture with Kodak 3X (400 ASA film) or in black and white with Kodak Colour film or in some cases as colour isotherm pictures.

The patients were examined in a separate draught free room. The patient lay with the legs slightly apart and elevated about 20° to avoid venous pooling (Fig. 1). The patients were allowed to lie for approximately 10 minutes to achieve thermal equalibration. The front of the calf and thigh and when possible the posterior surface of the calves and the popliteal fossa were studied. Phlebography was carried out according to the method described by Greitz[9] and others [10], [11]. The phlebographic interpretation was made without the radiologist being aware of the results of thermography (Tab. 1 and II).

## RESULTS

The thermographic appearance of a normal leg is seen in Fig. 2, A, B. Pretibial and prepatellar areas of cooling are seen. The thigh is usually an even grey but sometimes has a mottled pattern, especially in adipose

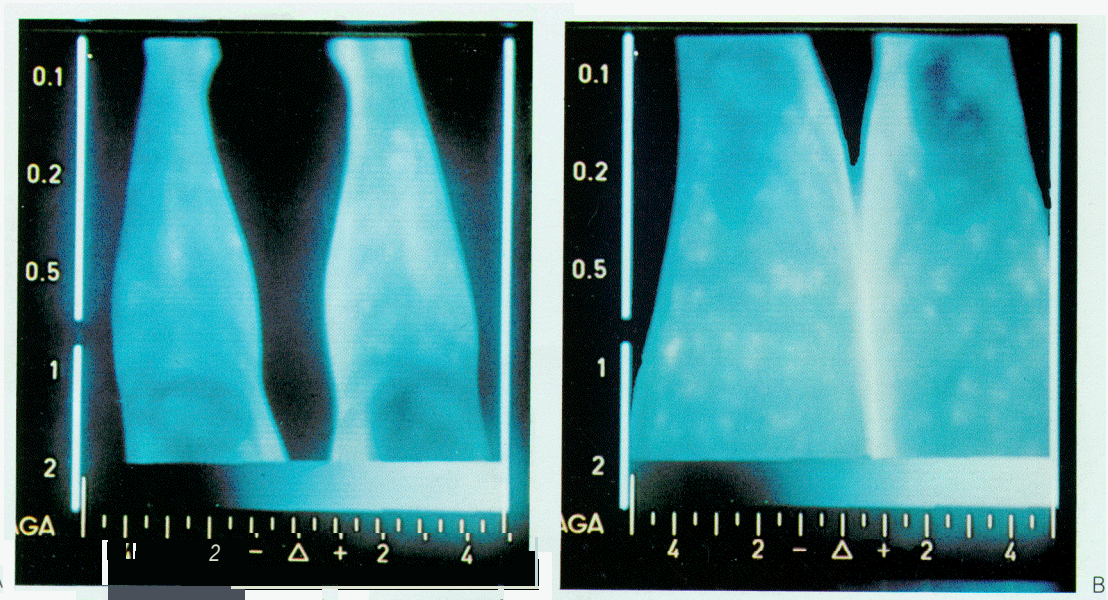



Fig. 2 A,B. Thermographic appearance of normal extremities. (A) Calves with pretibial and prepatellar cooling. (B) Thigh.

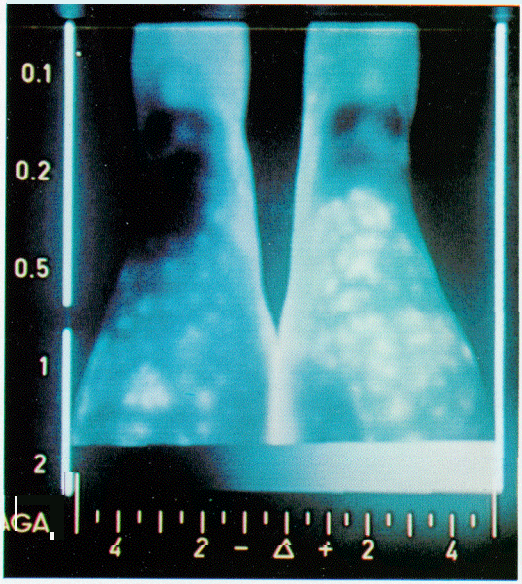


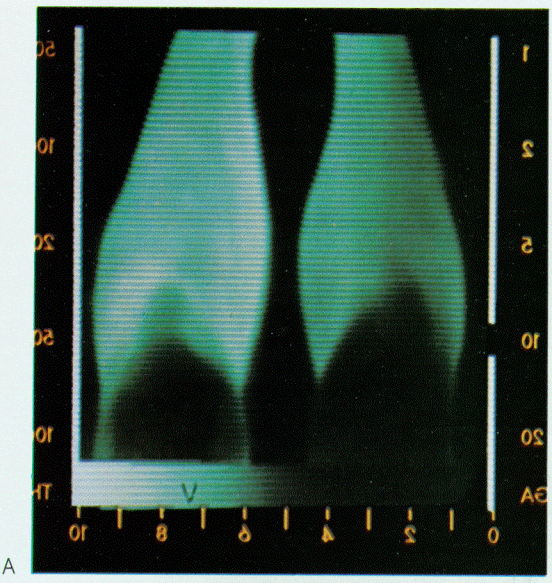

Fig. 3. Thigh with the mottled pattern commonly seen in adipose patients.

patients (Fig. 3). When a calf deep venous thrombosis is present the pretibial cooling is diminished or absent, (Fig. 4, A, B). When the thrombosis is arising in a proximal direction prepatellar cooling is also diminished or absent (Fig. 5, A, B, C). In calf and popliteal deep venous thrombosis, pictures of the posterior surface are valuable for interpretation. A femoral vein thrombosis is seen on the thigh pictures with absence of the mottled pattern and generally increased temperature.

Tab. II. **Comparison between thermography and phlebography in localization of the DVT.**

| | |
|---|---|
| Calf DVT (thermography - phlebography) | 34 |
| Thigh DVT ithcrmography phlebography) | 3 |
| Calf and thigh DVT (thermography phlebography) | 30 |
| Calf DVT (thermography), calf and thigh DVT (phlebography) | 16 |
| Calf and thigh DVT (thermography), calf DVT (phlebography) | 3 |
| | 86 |

Thus, it is mainly the total picture that deternlines the diagnosis and not the absolute leg temperature or the temperature difference between the legs. This makes it possible to diagnose bilateral thrombi also. Inflammation gives increased heat of the skin (Fig. 6).



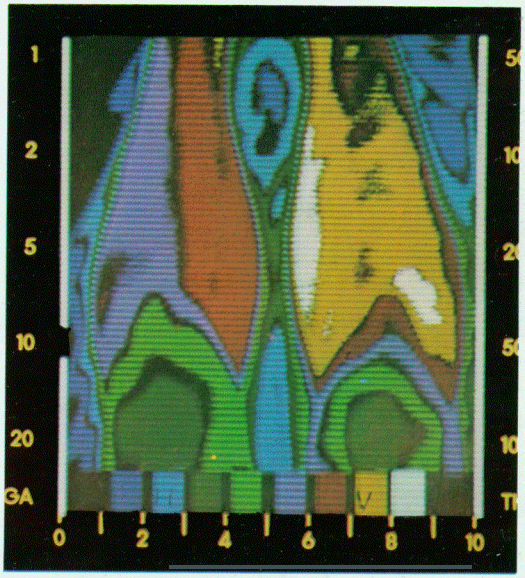
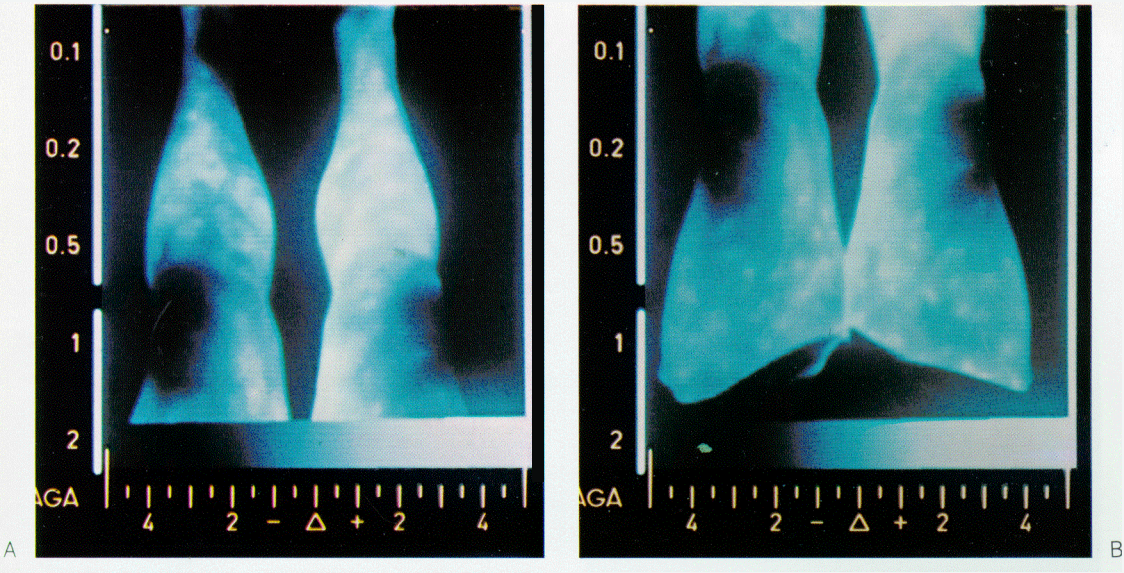




Fig. 4 A-B. Thermogram showing deep venous thrombosis located to the calf on one side (A) Grey scale, (A) Colour scale.



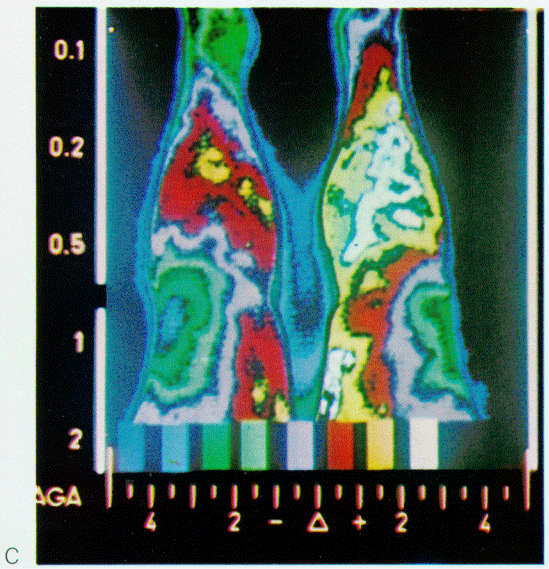




Fig. 5 A-B-C. Thermogram showing deep venous thrombosis located to the whole leg.

## SCREENING OF POSTOPERATIVE THROMBOSES

According to the above mentioned criteria for. deep veous thrombosis thermography was compared with $^{125}$I-fibrinogen test in postoperative screcning of thromboses (Table III). The overall agreenient is Xl 81%. 6.1% false positivc thcrmograms were found. It must be pointed out that only the thermographic picture has been used as parameter, and no compa-

Tab. III. Screening of postoperative DVT. Comparison between thermography and $^{125}$I-fibrinogen test. Agreement 81.0%.

| | *positive thermography* | *negative thermography* |
|---|---|---|
| positive $^{125}$I-fibrinogen test | 126 | 77 |
| negative $^{125}$I-fibrinogen test | 40 | 373 |

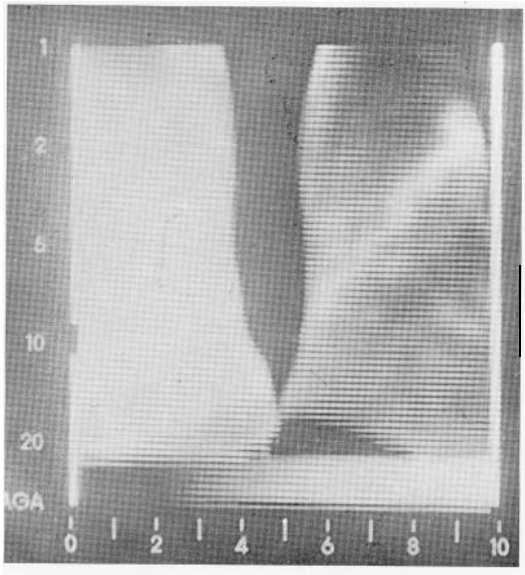



Fig. 6. Thermogram showing located superficial thrombophebitis on one side and wide spread superficial thrombophlebitis on the other side.

rison between the thermographic picture and the clinical status of the leg has been performed. As $^{125}$I-fibrinogen test is also very sensitive for detecting minimal calf thrombi, an analysis has been made based on the localization of thrombi (Table IV).

Tab. IV. **Screening of postoperative DVT. The importance of localization of fibrinogen test detected thrombi for the agreement with thermography.**

| | *Number of "'I-fibrinogen positive thrombi* | *Thermographic agreement (per cent)* |
|---|---|---|
| Calf | *115* | *53.0* |
| Thigh + calf | 88 | *71.2* |

The thermographic sensitivity for calf thrombi is 53.0% and 71.2% for thrombi in the thigh or thigh plus calf. These figures reflect the high sensitivity of $^{125}$I-fibrinogen test. Thermography and $^{125}$I-fibrinogen test have not been previously compared. Our results are promising but the frequency of DVT obtained with thermography is lower than that obtained by fibrinogen test. The very sensitive fibrinogen test may detect distal thrombi of leSs clinical importance.

## ACUTE DEEP VENOUS THROMBOSIS

According to the above mentioned criteria of deep venous thrombosis thermography was also compared with phlebography in cases with suspected DVT. The result is given in Table I. The agreement is 89.0%. There are 14 real discrepancies (two false positive and twelve false negative thermographic results). In the eight cases (figures within brackets in the table) the phlebographic findings are minimal and uncertain and in seven of the cases the phlebographic findings are located distally in the calf.

In Table II the thermographic and phlebographic localization of the thromboses are compared. There is full agreement in 67 legs (77.9%). In this material there were only three isolated femoral vein thromboses.

## DISCUSSION

This report has dealt with two problems. An evaluation was made on the use of thermography in suspected acute DVT and an analysis was made to see if thermography can be used as an instrument for screening of postoperative thromboses.

If acute deep venous thrombosis is suspected, thermography is a sensitive diagnostic method and there is a high degree of correlation between thermography and phlebography. The results are in full agreement with those obtained by Cooke and Pilcher and others [7, 8, 9]. Chudáček made a similar comparative study but the agreement was much less (55%).

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