ACTA THERMOGRAPHICA

Volume 1 Book 2

Content

Symposium on thermography of hone and joint diseases

SYMPOSIUM ON THERMOGRAPHY OF BONE AND JOINT DISEASES *

1. Historical introduction: thermography in Bath

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SUMMARY. The history of Bath as a centre for the treatment of rheumatic diseases is outlined. Developments in thermography in Bath have centred largely on rheumatology as well as on breast cancer and circulatory disorders. These developments are reviewed, and techniques for quantitation in thermography are described.

Key words: thermography; radiometry; rheumatology; anti-inflammatory drugs.

A) INTRODUCTION

We welcome the members of the European Thermographic Association to the clinical section of our congress, at the Royal Natjonal Hospital for Rheumatic Diseases, Bath. We feel that this hospital and this city make an appropriate centre for the Association's first meeting in this country as we have been involved here in the clinical applications of thermography for several years, especially in the fields of rheumatology and breast cancer.

1) Bath's History. There are historical reasons too why Bath is a good centre for our meeting. Because of its hot springs Bath has been a therapeutic centre for nearly 2,000 years, particularly for sufferers from rheumatic diseases. Some 2 million litres of water flow daily from the hot springs, with a constant temperature of 49°C. The Romans built their first bath system here in the first century AD, and the visitor today can see the extensive remains of the complex of buildings remaining from the 4 centuries of their rule here. Near the baths stood the temple dedicated to Sul-Minerva, for the Romans identified the local goddess Sul with Minerva, and named the city after her, Aquae Sulis.

After the departure of the Romans in the 5th century their buildings fell into ruins, and the main hot bath was completely lost until uncovered during rebuilding in the 19th century. But the waters, of course, continued to flow, and in Saxon and mediaeval times were being used again. The Abbey was founded in the 10th century, and the city was rebuilt; the Kings Bath and the Cross Bath were constructed and a continuous stream of visitors came to the city to bathe in its waters. There are many accounts of the medical use of the waters in past centuries, notably that of Leland in 1540, particularly for the treatment of bone and joint disease.

Following visits by royalty in the 17th and 18th centuries, Bath became a leading fashionable resort for the sick, and to accommodate the influx of visitors the city grew rapidly. Splendid terraces and crescents were built, using local stone, and it is the Georgian architecture of this era which still characterizes the city today. The city's unprecedented popularity in the 18'" century led to crowded social scenes and events in which

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* On the 9th and 10th April, 1976 the groups on Terminology and Teaching, on Industrial and Ecological Thermography, on Biothermometrology, the Executive Committee and the National Delegates of the European Thermographic Association met in Bath (England).

In that occasion a Symposium devoted to bone and ioint diseases was held at the Roval National Hospital for Rheumatic Diseases.

E. F. J. Rinn of the Roval National Hosnital for Rheumatic Diseases was "the President.

the visitors behaviour often left much to be desired. This was remedied by the firm regulations imposed by the master of ceremonies, Beau Nash, who introduced a strict code of manners for all who attended receptions in the Assembly Room, or who visited the Pump Room and Baths. It was Beau Nash who strongly supported the building of a hospital to house the sick poor visiting the city, and it was that hospital, opened in 1742, which has grown on the same site, into the Royal National Hospital for Rheumatic Diseases, where this part of our conference is now being held [7].

2) Sir William Herschel. At a meeting in Bath devoted to thermography we must make mention of William Herschel (Fig. 1). He was born in Hanover in 1738, came to England as a musician, and took the post of organist in the newly built Octagon chapel in Bath in 1766. While living here he developed his interest in astronomy, and it was in Bath that he discovered the planet Uranus with a telescope of his own making. After leaving Bath in 1788 he turned his wide ranging ingenuity to a study of the solar spectrum, and noted the transmission of heat in the infra-red zone beyond the visible spectrum. He is justly, therefore, recognized as the discoverer of infrared radiation. He was knighted in 1816, became president of the Royal Astronomical Society, and died in 1822. During this brief conference we have had the pleasure of meeting in the Octagon Hall, now no longer a chapel, where we heard a music recital given by the Herschel ensemble, which included compositions by Sir William Herschel himself.

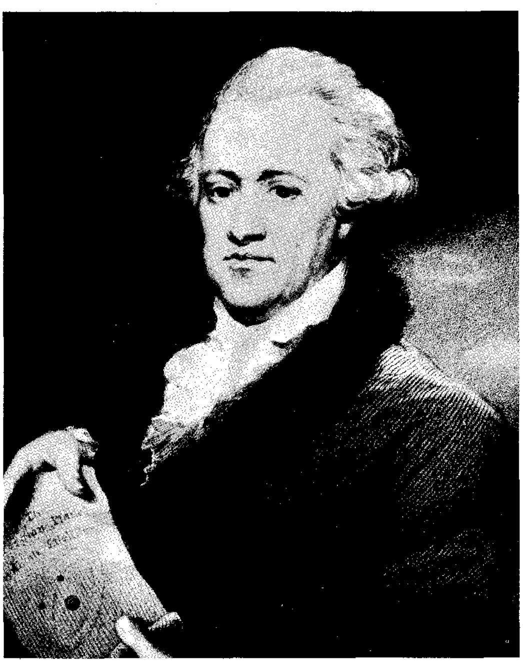


Fig. ***1. Sir William Herschel*** 1738-1822. Astronomer Royal and discoverer of the planet Uranus, who first described the transmission of heat in the infra-red portion of the solar spectrum. He came to Bath as musician and organist in 1766.

B) THERMOGRAPHY IN BATH

Our interest in thermography and its possible use in rheumatology was awakened in 1963 when the first thermographic camera became available in Britain. This was the Smith's Pyroscan, originally conceived as a possible navigational aid by infra-red scanning, and then developed for industrial and medical uses [2]. We found that in spite of its limitations, this thermograph would demonstrate changes in peripheral blood flow such as reactive hyperaemia following temporary arterial occlusion, and would also show abnormal temperature patterns due to inflammation in the skin or in underlying joints. We soon appreciated the need for standardization of environmental conditions for thermography, and we were fortunate that hospital reconstruction enabled us to set up a suitable temperature-controlled room in 1965 [6,9].

At this time Lloyd Williams was studying breast cancer by infra-red detection at the Middlesex Hospital, London, confirming the original observations of Lawson [14]. He established a relationship between the raised temperature of the skin over a breast tumour, measured with a distant thermistor, and the degree of malignancy of the tumour [17].

1) Radiometry

Following the work of Lloyd Williams we acquired a radiometer and used this in our studies of inflammation[26]. We compared the skin temperature over the knee with the intra articular temperature in rheumatoid arthritis, and showed that application of an ice pack to the skin caused a slight fall in the intra articular temperature. After removal of the ice pack the external and internal temperaturea rose gradually to their original level over about 20 minutes. The more acute the inflammation, the more rapid was the rewarming process. Injection of steroid into the knee caused a fall in the external and internal tcmperaturcs as described by Horvath and Hollander [13], and the rewarming process after ice became slow once more, as in a normal knee [15]. We found too that an isotope scan of an inflamed knee, using I.V. technetium, revealed visually the intensity and site of inflammation; a day or two after an intra articular injection of steroid the reduction in intensity of isotope pattern was closely parallel to the fall in temperature of the joint' (Fig. 2).

We examined the relationship between the external temperature of an inflamed knee, mcasurcd by the radiometer, and the characteristics of the synovial fluid, obtained by serial aspiration. During the course of treatment wc found that temperature rose or Cell in parallel with the volume of synovial fluid, and with its protein content: howevcr there was no clear parallel between tcmpcraturc and the acid phosphatase content of the fluid [3]. In animal models too, it was found that radiometry provided a simple and useful guide to the progress of inflammation and the action of an anti inflammatory drug such as azapropazone [4].

2) Thermography

The information given by radiometry is of course limited as it tells us nothing of the heat patterns in the skin, which are displayed by thermography. For over 10 years we have had a thermography laboratory at this hospital where we have been mainly concerned with the applications of thermography in rheumatology. Most of our experience has been with the Bofors instrument, but we have also made use of the Aga [10].

Another thermography laboratory in Bath, at the Royal United Hospital, has continued to study heat patterns of the breast, the variations associated with menstruation, contraceptive hormone therapy, and the detection of breast cancer [16]. Other subjects studied have included varicose veins in the leg, with the detection of points of communication between superficial and deep veins [18, 19] and heat patterns of the face and forehead in patients with occlusive lesions of the internal carotid artery [20, 21].

Owing to this activity in the two laboratories in Bath we have had experience of a number of different thermographic scanners. These have included the Rank and the EMI instruments, and the government prototype made by AWRE, Aldermaston and Barr and Stroud. This has enabled Ring to make a careful and critical evaluation of the features of many such instruments [22]. He paid particular attention to sensitivity, definition of display and stability of the instruments reviewed. Once again, as a result of this

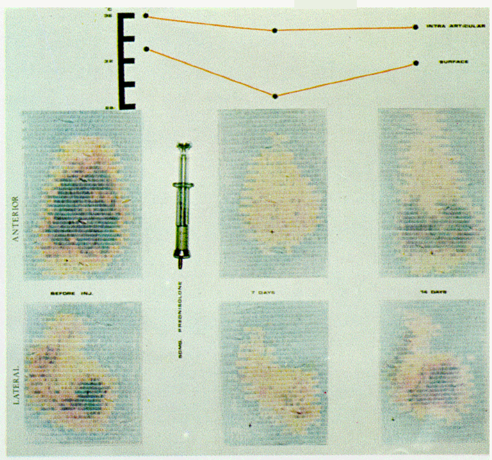


Fig. 2. Technetium scintigrams, anterior and lateral, of knee joint in a patient with rheumatoid arthritis. The acutely inflamed, highly vascular svnovium produces intense localization of the isotope (left). 50 mg of prednisone was injected intra-articularly, with marked reduction of inflammation and vascularity 7 days later, and a return of inflammation at 14 days. The associated fall and later rise of skin temperature, measured by radiometer is shown above, with the corresponding, much slighter, fall in intra articular temperature measured by thermistor.

review, we were reminded of the importance of stability in the instrument, standardization of environment in the thermography room, proper preparation of the patient, and the need for a standard temperature reference source for inclusion in the thermogram. Moreover, physiological diurnal variations in temperature must be borne in mind. Variations appear to be least in the morning hours, which are therefore preferred for any serial clinical studies[23].

Our main application for thermography in this hospital has been in the study of rheumatoid arthritis and similar forms of inflammatory polyarthritis. We have been fortunate in that the large number of patients undergoing knee synovectomy has made it possible to compare pre-operative thermograms of the knee with the intra-articular appearance seen at operation [11,23]. In a series of 100 patients so studied, Pinder and Ring consistently found a close relationship between the sites of maximum synovial vascularity within the knee (which are subject to considerable individual variation) and the superficial heat pattern revealed by thermography. In a number of instance, the thermogram was of value in directing the surgeon's attention to regions of the synovium requiring special attention at operation.

For serial thermographic studies of inflammatory arthritis and its response to treatment, it is essential to have some form of quantitation of the thermogram. Up to a point this can be achieved by used of a line scan, or by following changes in a single isothermal area [24]. However, methods based on measurement of areas of isotherms are difficult and time consuming, and only become practicable if a computerized technique is available.

We were able to link a cathode ray display tube and a Nukab computer to our Bofors thermograph in 1973, and have dealt with the problem of quantitation in this way. In the first place, this equipment produces a point by point and line by line print-out of skin temperatures in any required area of the completed thermogram. This thermogram can be retained indefinitely in the computer memory, or stored ready for recall at a later date. Simpler still, the « thermographic index » can be calculated and recorded virtually instantly for any required portion of a completed thermogram. This thermographic index is derived from the areas of the isotherms displayed within the portion, or area, being analysed'. Such a figure, indicative of the acuteness of inflammation in an affected joint, can be recorded as often as necessary during the course of joint disease, or throughout a period of treatment, with perfect safety to the patient. It has been applied in the assessment of non steroid anti-inflammatory drugs [25] and in the comparison of the effects of different steroids injected intra articularly [12].

Clearly, thermography now has much to offer in this aspect of the field of clinical pharmacology' in that it provides a safe, repeatable method for an objective assessment of inflammatory disease and its response to treatment.

REFERENCES

1. BACON P. A., COLLINS A. J., RING E. F. J., Cosh J.A.: Thermography in the assessment of inflammatory arthritis. ***Clin. Rheum. Dis., 2,*** 51-65, 1976.
2. CADE C.M.: High-speed thermography. ***Ann. N. Y. Acad. Sci.,*** 121, 71-79, 1964.
3. COLLINS A. J., COSH J. A.: Temperature and biochemical studies of inflammation. ***Ann.*** Rheum. Dis., 29, 386-392, 1970.
4. COLLINS A. J., RING E. F. J.: Measurement of inflammation in animals and man by radiometry. ***Brit. J. Pharmacol, 44,*** 145-152, 1972.
5. COLLINS A. J., RING E. F. J., COSH J. A., BACON P. A.: Quantitation of thermography in arthritis using multi-isothermal analysis. I The thermographic index. ***Ann. Rheum. Dis., 33,*** 113-l 15, 1974.
6. COSH J.A.: Infra-red detection in the assessment of rheumatoid arthritis. ***Proc. roy. Soc. Med.,*** 59, Suppl. on Measurement in Therapeutic Assessment, 88-93, 1966.
7. COSH J. A., KERSLEY G. D.: Rheumatic treatment centres in Britain: Bath, ancient and modern. ***Ann. Phys. Med.,*** 10, 167-174, 1969.
8. COSH J. A., LINDSAY D. J., RHYS DAVIES E., RING E. F. J.: The technetium scintigram as an indicator of synovial vascularity in rheuma-

toid arthritis: its comparison with the results of temperature measurement. ***Ann. Rheum. Dis.*** **29,** 691, 1970.

9. **Cosh** J. A., **Ring** E. F. J.: Techniques of heat detection used in the assessment of rheumatic diseases. ***J. Radiol. Electrol., 48, 84-89,*** 1967.

10. **Cosh** J. A., **Ring** E. F. J.: Thermography and rheumatology. ***Rheumatol. and Phys. Med.,*** **10, 342-348,** 1970.

11. Cosh J. A., **Ring** E. F. J., **Collins** A. J., **Pinder** I. M.: Application of radiometry and thermography in rheumatic diseases. ***Excerpta Medica*** 299: XIII International Congress of Rheumatology, Kyoto. Abstract 653,-1973.

12. **Esselinckx** W., **Demottaz** D., **Ring** E. F. J., **Collins** A. J., **Bacon** P.A.: Comparison of intra articular steroids in rheumatoid arthritis by thermography. In press. 1976.

13. Horvath S. M., **Hollander** J. L.: Intra articular temperature as measure of joint reaction. ***J. Clin. Invest., 28, 469-473, 1949.***

14. Lawson R.N.: Implications of surface temperature in the diagnosis of breast cancer. ***Canad. med. J., 75, 309,*** 1956.

15. Lloyd Williams F., Ring E. F. J., **Cosh** J. A.: Assessment of anti inflammatorv effect of intra articular steroids by means of external temperature measurement. ***Ann. Rheum. Dis., 29,*** **196,** 1970.

16. Lloyd Williams K.: Thermography in the prognosis of breast cancer. ***Bibl. Radiol., 5,*** 127-129, 1968.

17. Lloyd Williams K., **Cade** C. M., **Goodwin** D. W.: The electronic heat camera in medical research. ***J. Brit. I.R.E., 25,*** 241-250, 1963.

18. **Patil** K. D., **Lloyd Williams** K.: Thermographic study of heat flow in the detection of incompetent perforating veins. ***Surg. Gynaec. Obstet.,*** **132, 396-402,** 1971.

19. **Patil** K. D., **Williams** J. R., **Lloyd Williams** K.: Thermographic localization of incompetent perforating veins in the leg. ***Brit. med. J.,*** **1,** 195-197, 1970.

20. Phillips B. H., **Lloyd Williams** K.: An evaluation of thermography in carotid insufficiency. ***Proocedings of international conference on blood flow measurement.*** Sector publishing, London, 1974.

21. **Phillips** B.H., **Lloyd Williams** K.: The clinical uses of thermography. ***Brit. I.*** *Hosp.* ***Med. (Equipment supplement) 1974.***

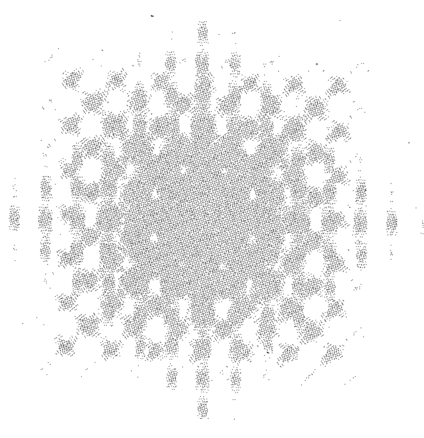
22. **Ring** E. F. J.: Equipment for medical thermography. ***Brit. J. Hosp. Med. (Equipment supplement), 5, 24-28, 1971.***

23. **Ring** E. F. J.: Thermography and rheumatic diseases. ***Bibl. Radiol., 6, 97-106,*** 1975.

24. **Ring** E. F. J., **Collins** A. J.: Quantitative thermography. ***Rheumatol. Phys. Med.,*** **10, 337-341, 1970.**

25. Ring E. F. J., **Collins A. J., Bacon P.** A., **Cosh** J. A.: Quantitation of thermography in arthritis using multi isothermal analysis. II Effect of nonsteroidal anti inflammatory therapy on the thermographic index. ***Ann. Rheum. Dis., 33, 353-356, 1974.***

26. Ring E. F. J., **Cosh** J. A.: Skin temperature measurement by radiometry. ***Brit. med. J., 4,*** 448-449, 1968.



2. Radiological, isotopic and thermographic studies in rheumatic arthritis

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SUMMARY. Due to the results obtained by comparing the radiological, scintigraphical and thermographical findings, it is stressed that thermography represents a valuable adjunct to the diagnosis of rheumatic diseases. It is useful for assessing the localization, extent and course of inflammatory joint disease. The evidence of restricted peripheral circulation may, in due course, help in a fuller understanding of the early stages of the rheumatic diseases.

Key ,words: thermography; rheumatic arthritis; methodologic comparisons.

Radiological 'investigations for the rheumatic diseases normally demonstrate processes which have already changed the bone structure and its calcium salt content, e.g. only a demineralization of 30% to 50% can be demonstrated radiologically. For this reason attempts are made to demonstrate earlier stages of osseous transformation using osteotrophic radionuclides.

99 mTc-polyphosphate-scintigraphy is ba-

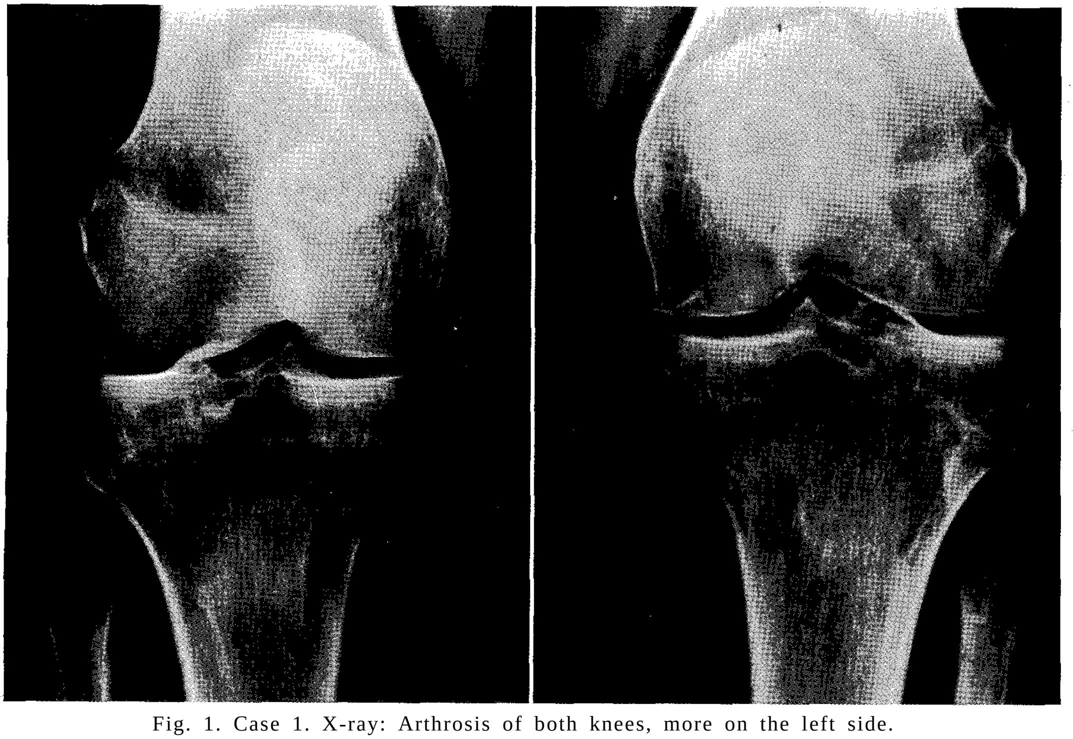


Fig. 1. Case 1. X-ray: Arthrosis of both knees, more on the left side.

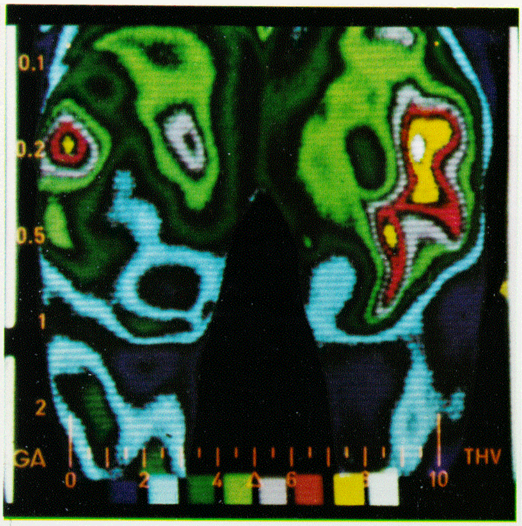
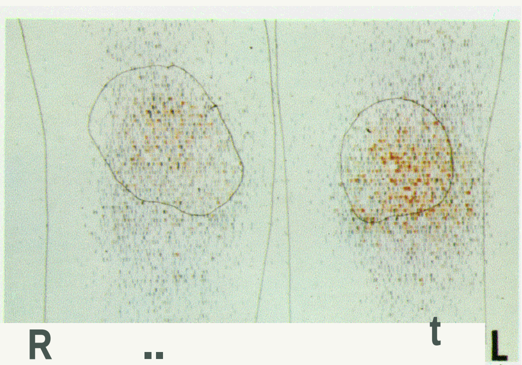


Fig. 2. Case I. Corrcaponding thermogram: in- tlammatory changea on both aides in the lateral parts of the kneea, increased on the left.



Elg. 3. Case 1. Corresponding scintlgram: incrca- scd radionuclide uptake on the left side. also in the lateral pat 01 the knee.

sed on an unspecific radionuclidc accumulation in regions of increased bone transformation. In rheumatic diseases, an additional storage in the inflamed joint occurs due to changed vascularisation and permeability produced by synovitis. In bone scintigraphy through a single isotope application all joints are subject to an essentially lower radiation exposure than in a corresponding radiological examination.

Thermography does not involve radiation exposure at all. Its applicability depends on the inflammatory rheumatic process leading to an increased infrared radiation and a raised vascularization.

Wc tested thermography as an independent method in a randomly selected patient group suffering from rheumatic diseases. For the purpose of the routine programme, hands, knees and feet of the patients were examined. The other joints were only considered in the cabe of complaints.

The inflammatory rheumatoid **process can** bc well demonstrated on knee, hand and foot joints. Demonstration on shoulder and hip joints, however, is limited due to the overshadowing of the soft tissue layers. In many cases, however, even in these joints the changes can be recognized.

Inflammation is marked by hyperthermia or hypcrvascularization of the joint which correlates with the extent and intensity of the rheumatoid disease. Exact localization is possible where small or medium changes correlate with the scintigraphic findings (Figs. 1, 2, 3: Case 1; Figs. 4, 5, 6: Case 2). In extensive pathological processes, the thermographic changes are so distinct that single areas of joints cannot be differcntiatcd.

Marked changes in the thermogram are observed by the time early radiological changes are been (Figs. 7, 8: Case 3).

Thermographic diagnosis can also be established when radiological joint ashebbrncnt is no longer possible due to anatomcal abnormalities. Following replacement of the **lwx joint** by an endoprosthcsis, only the function of the prosthesis can be assessed radiologically and not the inflammatory process. Thermography confirms not only the pathological findings, but substantiates the therapeutic success during control after therapy. In the x-ray picture, the assessment of the osseous structure **is** inhibited by the overshadowing of the endoprosthesis, but in the thermogram the prosthetic non-inflamed joint presents a normal thermographic appearance (Figs. 9, 10, 11: Case 4).

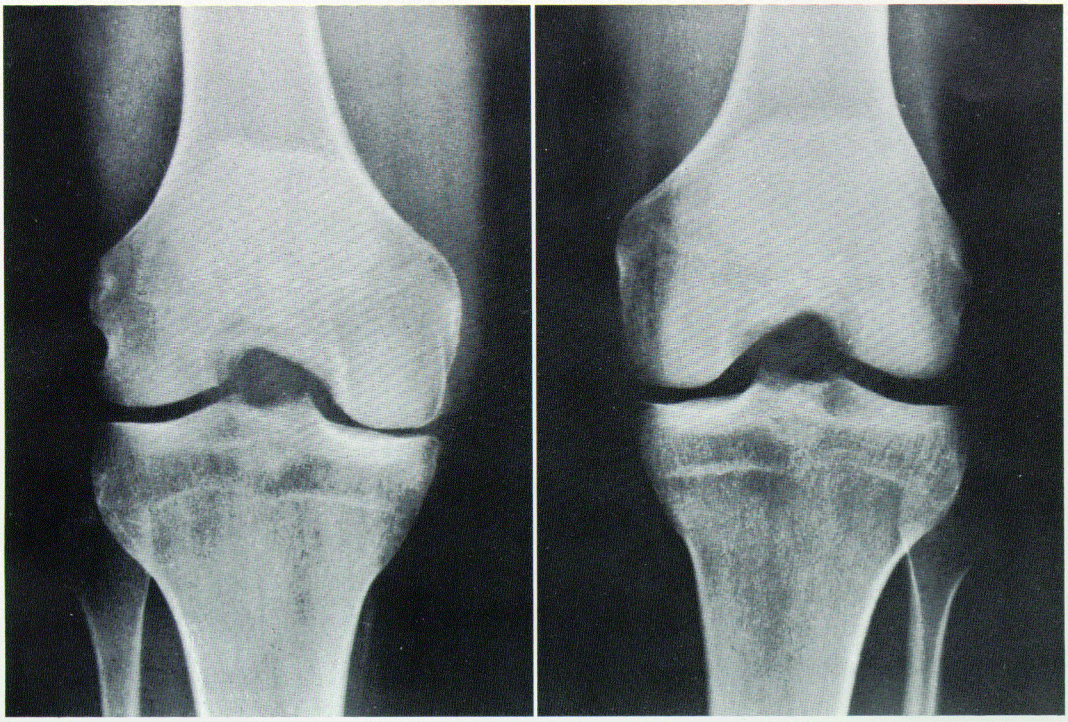


Fig. 1. Case 2. X-ray Onlv slighi natrowing ot the artlcular apacc on the right.

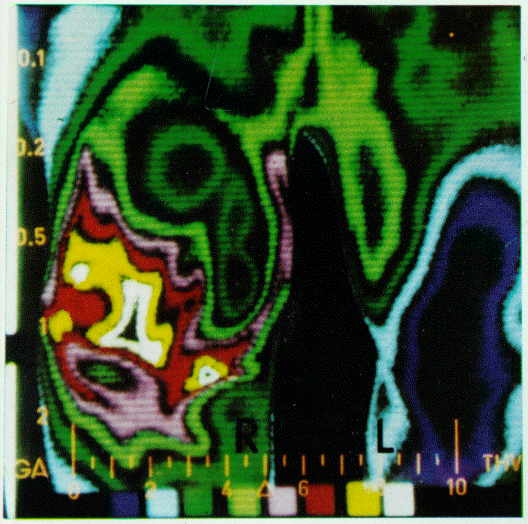


Fig. 5. Cast 2. Thermogram: Severe gonarlhritis un the right, mainly lateral.

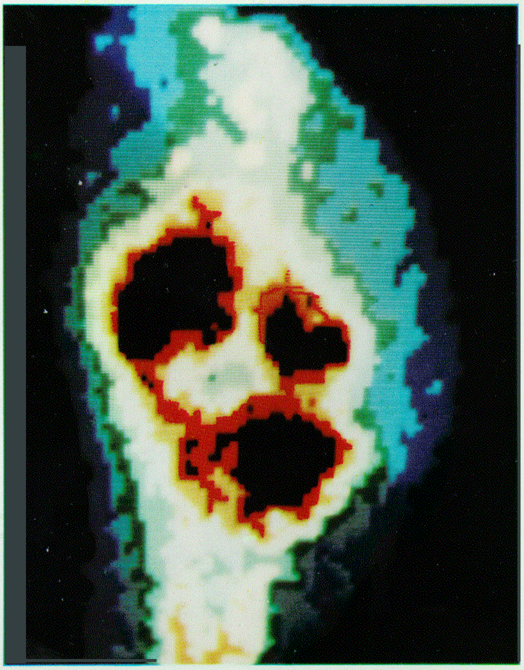


Fig. 6. Case 2. Scintigram increased radionuclidc uptake (right).

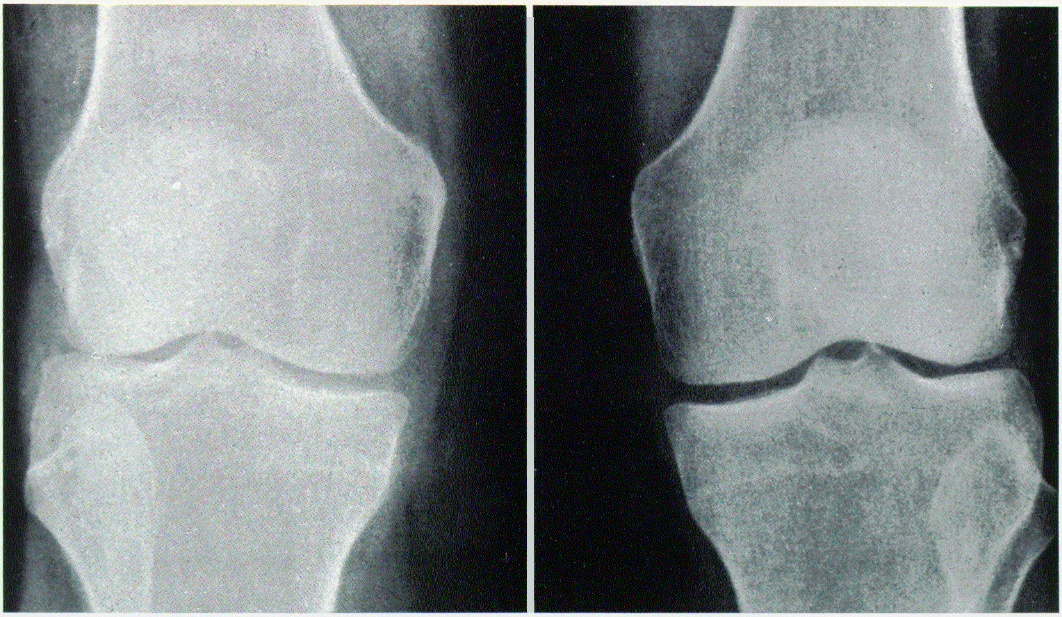


Fig. 7. Case 3. X-ray: Only slight asymmetry of the articular space on the right.

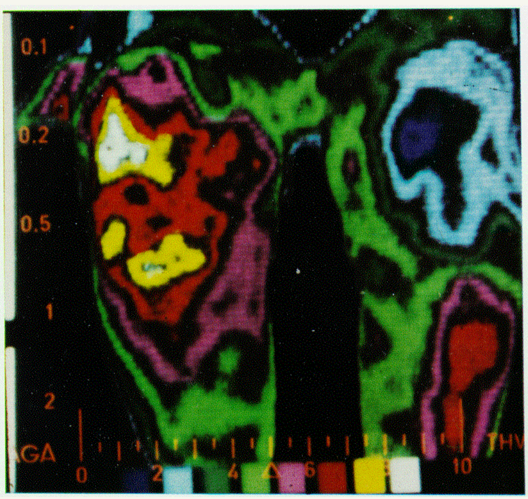


Fig. 8. Case 3. Thermogram: Severe inflammation of the right knee.

Thermography is able to either demonstrate or exclude additional inflammation in gross arthritic changes (Figs. 1, 2, 3). Dc-generative articular changes, however, can only be demonstrated by radiological examination. However, the combination of an inconspicuous thermogram with arthritic changes in the x-ray picture, does provide a thermographic baseline for the detection of an acute inflammatory episode.

In patients with rheumatoid disease, thermography can be used not only to exclude inflammation, but also demonstrate an underlying vascular process, thus sparing the patient time-consuming investigations which may be associated with considerable radiation exposure. A peripheral angiopathy, which occurs e.g. in Morbus Raynaud, can be well dcmonstratcd by this means, although not by x-ray or scintigraphy.

Since the thermographic diagnosis is based on assessment of the vascular system and local temperatures, it is impossible to demonstrate inflammatory articular changes, if there is an accompanying pathological process as e.g. a leg phlebothrombosis or an abnormal arterial process, as e.g. a gangrene.

In an extraordinary high percentage of our examinations, we were able to demonstrate significantly restricted peripheral circulation. This can only partly be explained by the age distribution of the group and the arteriosclerotic vascular process. These

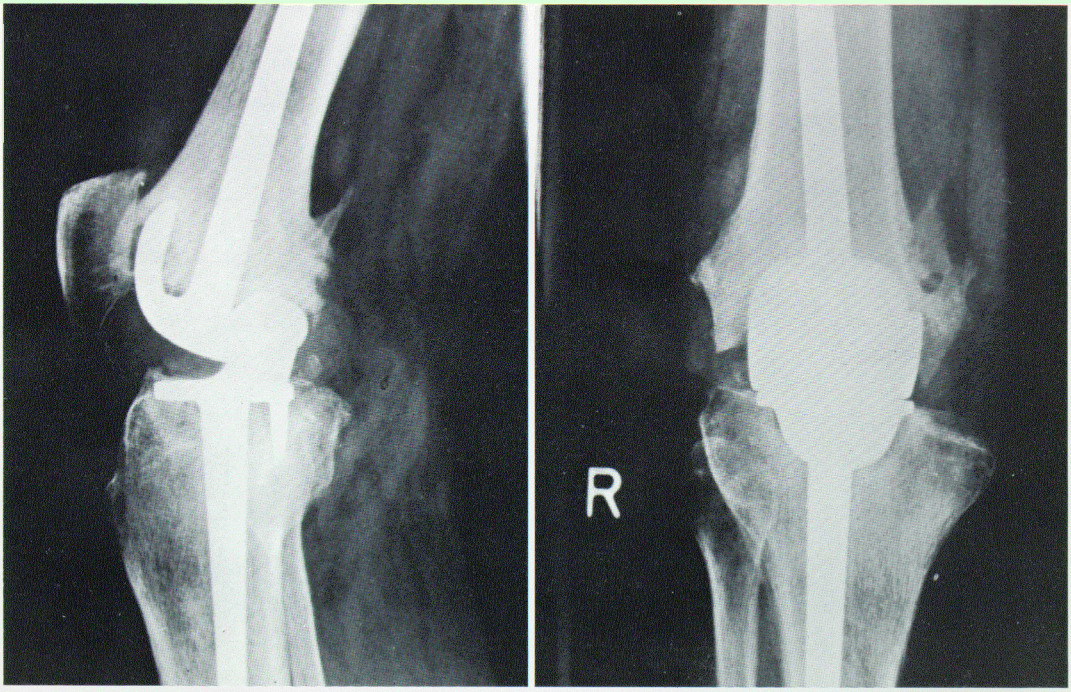


Fig. Y. Case 4. X-ray: 9 months after implantation 01 an cndoprothcsis.

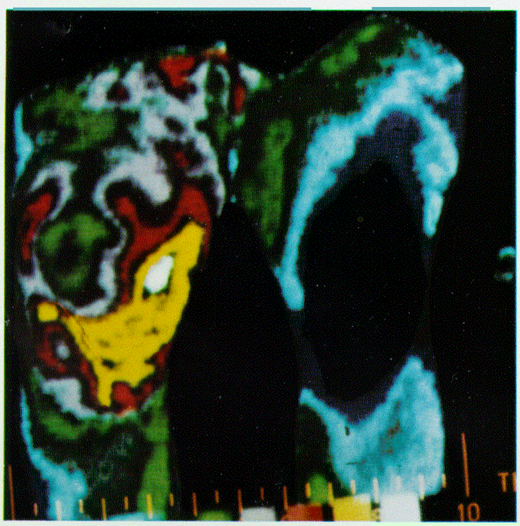


Fig. IO. Case 4. 'l'hcrmopram: Persiatcnt itctivc' arthritis in the right tcncc.

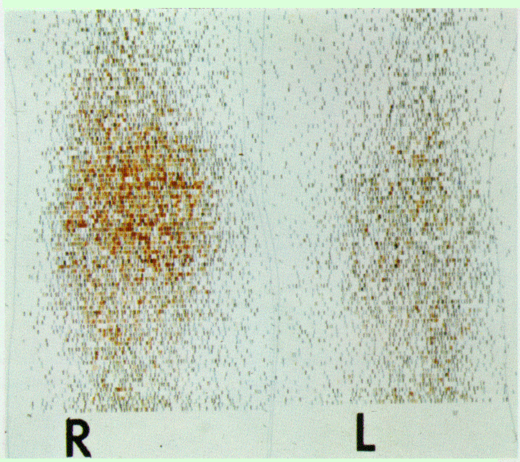


Fig. I I. Cast 4. Scintigram: Greatly increased uptake in the right knee.

findings are significantly increased in juvenile patients in whom the osseous processes were not shown by radiography or scintigraphy. We believe this to be a nonspecific early indication of a rheumatoid process affecting the peripheral vascular system. These results correspond with recent arteriographical and immunological studies.

REFERENCES

1. **Alexander** K.: Die GefCRschaden bei chronischer Polyarthritis, *Dtsch. med. J., 94,* 318-324, 1969.
2. **Bywaters** H. G. L.: Peripheral vascular obstruction in rheumatoid arthritis and its relationship to other vascular lesions. *Ann. Rheum. Dis.,* 16, 84-103, 1957.
3. **Fassbender** H. G.: Pathologic und Pathogenese der GefaRprozesse bei chronischer Po'iyarthritis. *Med. Welf,* 26, 1123-1125, 1975.
4. **Leb** A.: Die Rdntgenserienvasographie des periarticularen GefSiRapparates bei rheumatischer Polyarthrose. *RiiFo, 75, 251-258,* 1951.
5. **Paronetto** F.: Systemic nonsuppurative necrotizing angiitis, in Textbook of *Imunopathology,* Grune & Stratton, New York 1969.
6. **Pfannenstiel** P.: Szintigraphie von Knochen-, Knochenmark und Gelenken. *Med. Welt, 24,* 343, 1973.
7. **Potter** J. L., **Vigzell** F. W.: Capillary resistance in rheumatoid arthritis. *Ann. Rheum. Dis.,* 16, 357-364, 1957.
8. **Schillinc** F.: Entziindliche GefaRverEnderungen und rheumatische Erkrankungen. *iirztl. Praxis, 24,* 3621, 1972.
9. **Sokoi.off** L., **Bunim** J. J.: Vascular lesions in rheumatoid arthritis. 1. *Chron. Dis., 5, 668,* 1957.
10. **Subramanian** G., **McAffeb I.** G.: New complex of 99mTc for schelettal imagining. *Radiology,* 99, 192, 1971.
11. **Vorlaender** K. 0.: Zur Klinik und Immunologie entziindlicher Geflbprozesse. *Angiologie-Colloauium Herrenalb. 1976.*
12. **WILKINSON** M., **TorRance** W. N.: Clinical background of rheumatoid vascular disease. *Ann. Rheum. Dis., 26, 475-479, 1967.*

3. The thermographic examination of sacroiliac joints

by M. SADOWSKA-WROBLEWSKA, S. KRUSZEWSKI,
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SUMMARY. **Using the AGA 680 Thermovision camera and the isotherm system the temperature in 100 healthy persons and 22 ankylosing spondylitis patients was measured in the following regions: 1) the lower part of the lumbar spine, 2) the iliac crest, 3) the upper part of the sacroiliac joints, 4) the lower part of the sacroiliac joints and 5) the base of the caudal bone. It has been shown that there is a symmetric and characteristic temperature profile of the sacroiliac region, although there may be large differences in temperature in the individual cases. In AS. patients the temperature profile in the lumbosacral region had a different and often asymmetric shape, but no statistically significant differences in the temperature of the lumbosacral region among A.S. and healthy group were observed.**

Key words: thermography; ankilosing spondilitis; sacroiliac joints.

Radiological diagnosis of inflammatory changes of sacroiliac joints may cause some difficulties, especially in early stages of the disease. In recent years more attention has been given to new diagnostic method for evaluating these joints.

From the theoretical point of view, thermography, which shows changes in regional heat and quantitatively defines its intensity, should give evidence of heat in the area of inflamed sacroiliac joints in cases of their inflammatory changes.

The possibility of using thermography for evaluating the dynamics of inflammatory changes in sacroiliac joints has been reported by Cosh and Ring[2,3], Sadowska-Wroblewska and co-workers[4] and Agarwal and co-workers [1].

The thermographic examination of sacroiliac joints previously reported have not been related to the normal subject.

The purpose of this study is to estimate the temperature of the sacroiliac region in healthy subjects and evaluate the usefulness of thermography in the diagnosis of ankylosing spondylitis.

Methods

Thermographic examination was performed with the AGA 680 Thermovision. Patients were lying uncovered in a prone position in a room at a temperature of 18°C for 10 minutes before and during examination. A temperature reference source was

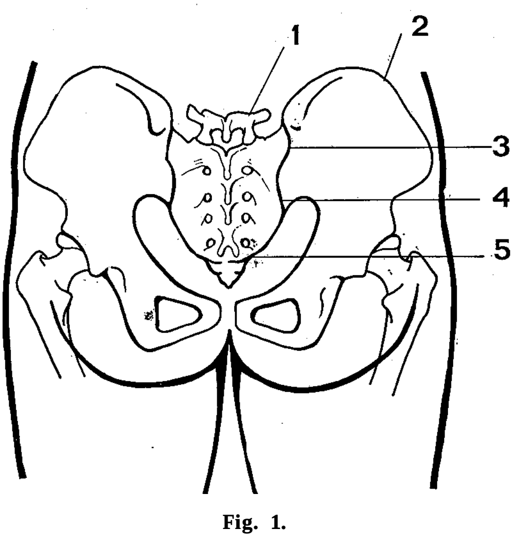


Fig. 1.

positioned close to the area examined for calibration purposes.

Using the isotherm system, thermograms were recorded, and the temperature of the following 5 regions measured:

1) The lower part of the lumbar spine; 2) the iliac crest; 3) the upper part of sacroiliac joint; 4) the lower part of sacroiliac joint; 5) the base of the caudal bone. Points No. 2, 3, and 4 were measured separately on the right and left side (Fig. 1). For some patients photographic recording with coloured filters was employed.

Material

Thermographic examinations were performed on 100 healthy persons (50 male and 50 female) from the age of 20 to 55 years (27 years on average). 22 ankylosing spondylitis patients (12 male and 10 female) in the age group 21-52 years (30 years on average) were examined (Table I). The diagnosis was estimated according to the New York criteria.

Tab. I. **Thermographic examinations.**

	Total *n*	*m.* *n*	*n*	*Age.* *in years*	*Average age*
Healthy persons	100	50	50	25-55	27
A.S. patients	22	12	10	21-52	30

Results

In the normal subjects the temperature of the sacroiliac region was the same on the right and left side.

In men the temperature of the whole lumbosacral region varied between 30°C and 36°C and in women between 29°C and 36°C (Table II).

In both sexes the highest temperature was noticed in the region of the lumbar spine then in the upper part of the sacroiliac joints and in the base of the caudal bone. The higher temperature in the lumbar spine and in the base of the caudal bone may be due to the vertical median hollow formed by the erector spinae muscles and gluteal muscles.

There are great differences in the temperature among the individual cases but the shape of the curve obtained from the temperature of the 5 above mentioned points was consistant in all the normal subjects (Fig. 2). In women the temperature of the lumbosacral region is slightly (but not statistically significantly) lower than in men. It may be due to the thicker fat tissue layer which is the bad heat conductor in that region found in women.

In males with ankylosing spondylitis the temperature of the whole lumbosacral region ranged from 30°C to 36°C and in female patients from 30°C to 35°C (Table III).

In some patients the asymmetry of temperature above the right and left sacroiliac joint was observed. The differences between both sides in individual cases ranged from *0.5°C* to *2.O°C*.

The lowest temperature in ankylosing spondylitis patients above the sacroiliac

Tab. II. **Thermographic examination of 100 healthy persons.**

Region	*Men* range from-to °C	*Men* average °C	*Men* S.D.	*Women* range from-to °C	*Women* average °C	*Women* S.D.
1. Lumbar spine	32,5-36	35,04	0,73	32-36	33,98	0,57
2. Iliac crest	30-35	33,51	1,39	29-34	32,O8	1,49
3. Sacroiliac joint upper part	32-36	34,08	0,9	31-35	33,05	1,23
4. Sacroiliac joint lower part	30-35	32,55	1,4	29-34	31,26	1,34
5. Caudal bone	31-36	33,97	0,99	29-35	32,87	1,65

Tab. III. Thermographic examination of 22 A. S. patients.

Region	*Men* range from-to °C	*Men* average °C	*S.D.*	*Women* range from-to °C	*Women* average °C	*S.D.*
1. Lumber spine	33-36	35,14	1,0	33-35	34,15	0,8
2. Iliac crest	30-33	31,67	1,1	29-33	31-80	1,6
3. Sacroiliac joint upper part	32-36	34,85	1,3	31-34,5	33,10	1,2
4. Sacroiliac joint lower part	31-35	33,04	0,7	30-34	32,02	1,4
5. Caudal bone	32-34,5	33,62	0,7	31-35	33,70	1,1

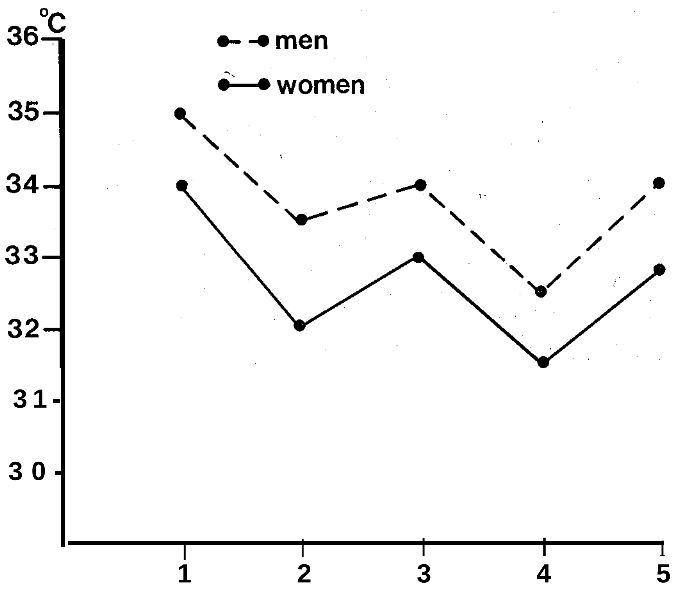


Fig. 2.

Tab. IV. Thermographic evaluation of sacroiliac region.

Region	*Men* average *temperature* *healthy* °C	*Men* average *temperature* *A. S.* °C	*t*	*p*	*Women* *average temperature* *healthy* °C	*Women* *average temperature* *A. S.* °C	*t*	*p*
1. Lumbar spine	35,07	35,14	0,15	>o,s	33,98	34,15	0,09	>0,9
2. Iliac crest	33,51	31,67	0,75	>0,4	32,08	31,80	0,04	>0,9
3. Sacroiliac joint upper part	34,08	34,85	0,26	>0,7	33,05	33,10	0,49	>0,6
4. Sacroiliac joint lower part	32,55	33,04	0,20	>0,8	31,26	32,02	0,27	>0,7
5. Caudal bone	33,97	33,62	0,17	>0,8	32,87	33,70	0,28	>0,7

joints recorded in some individual cases was 1” C higher than in the normal subjects but this did not prove to be statistically significant (Table IV).

Figure 3 shows the curve obtained from the average temperature of the 5 above mentioned points in ankylosing spondylitis male and female patients. The curves obtained

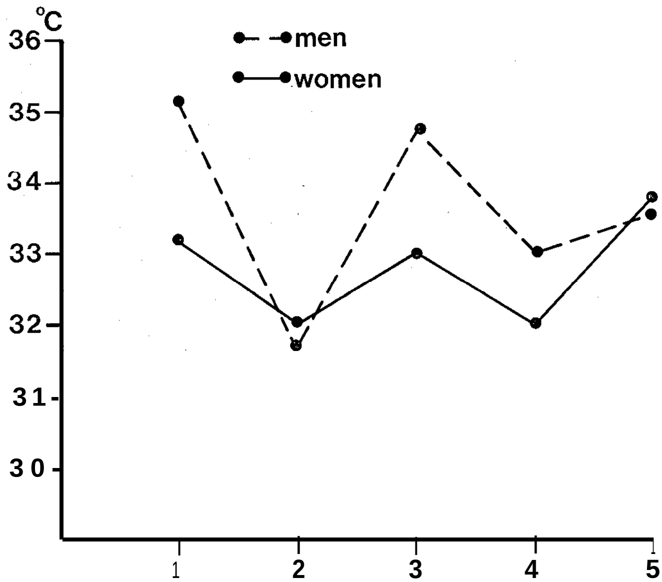


Fig. 3.

from individual ankylosing spondylitis cases took a different form from those of the normal subjects.

Figure 4 is an example of an ankylosing spondylitic male patient. There is the asymmetry between the right and left sacroiliac region and the curve obtained from the temperature of 5 points in the lumbosacral region had a different form from the normal.

Figure 5 shows the normal thermograms

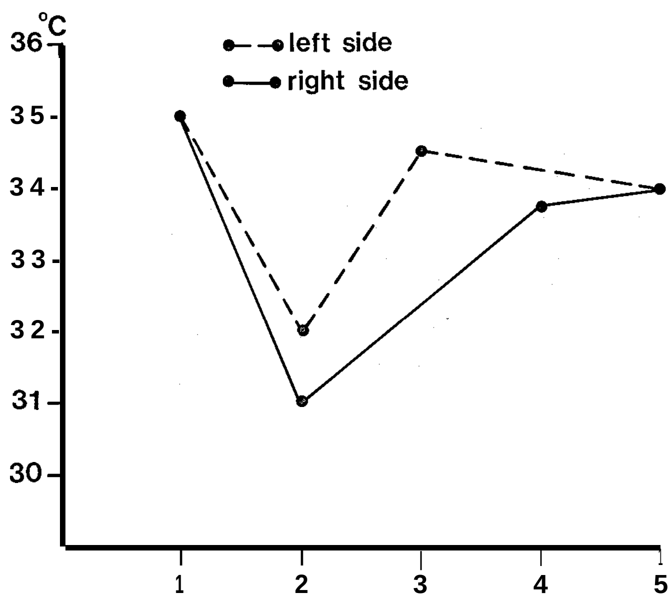


Fig. 4.

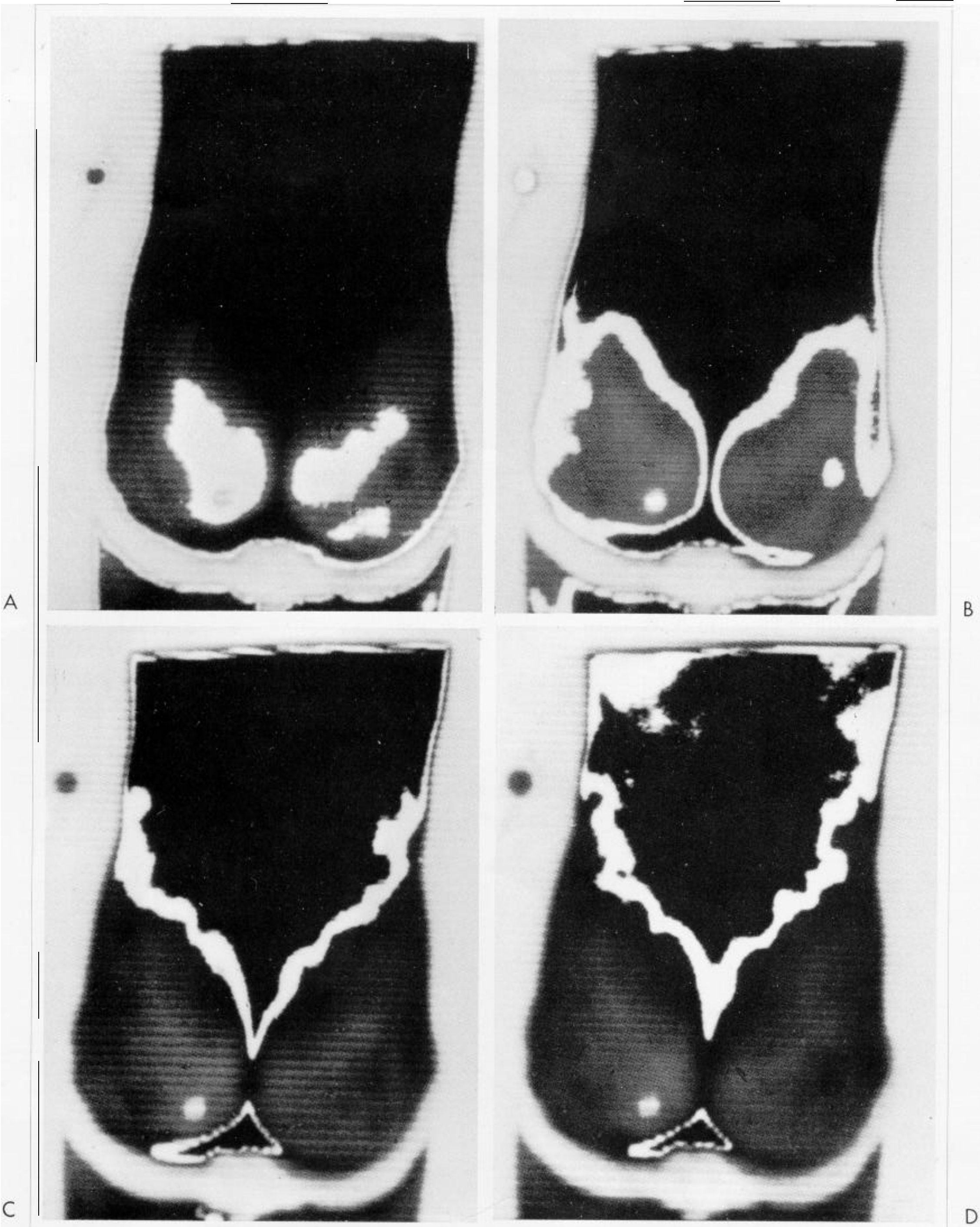
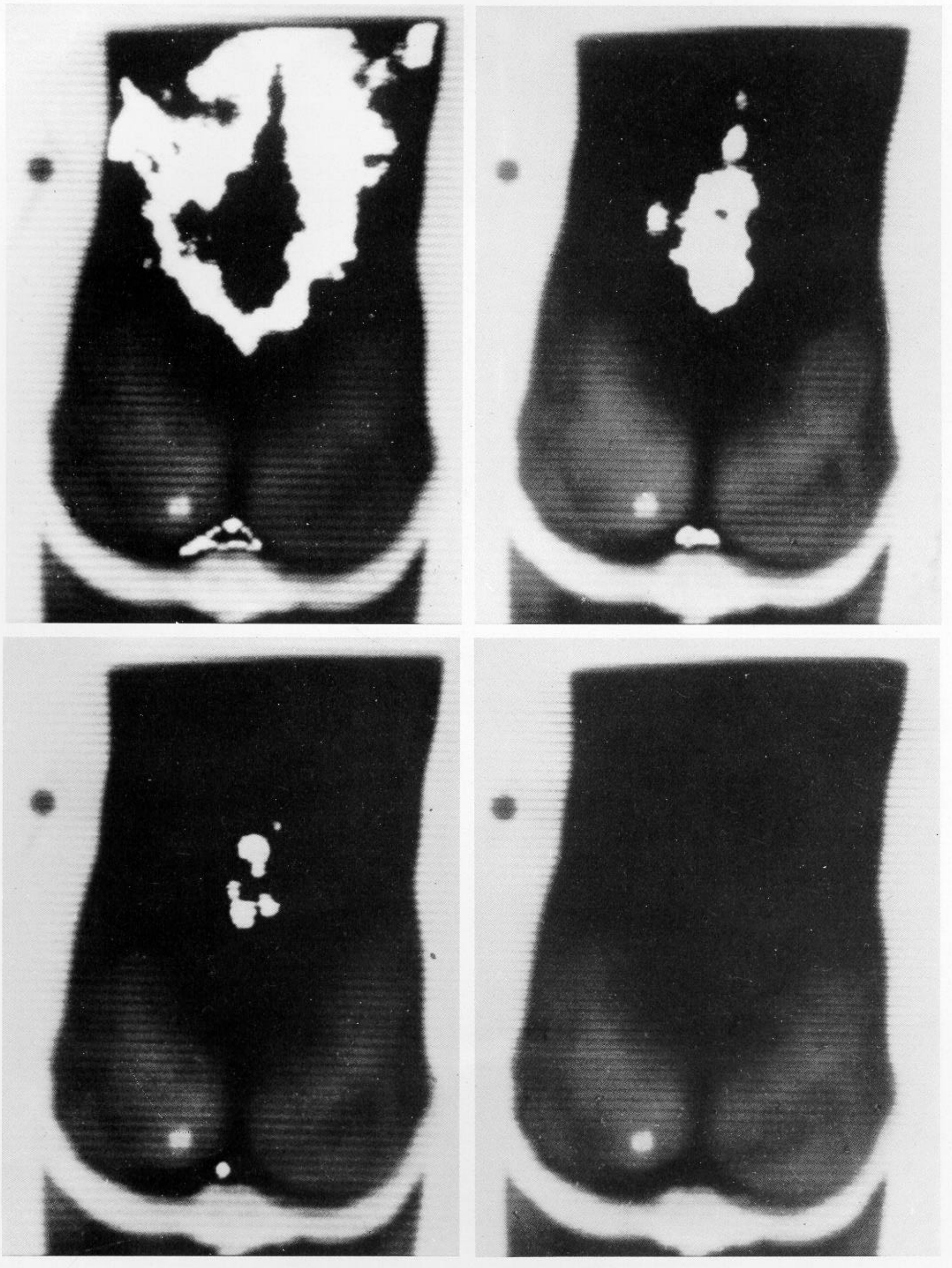


Fig. 5 A-B-C-C.

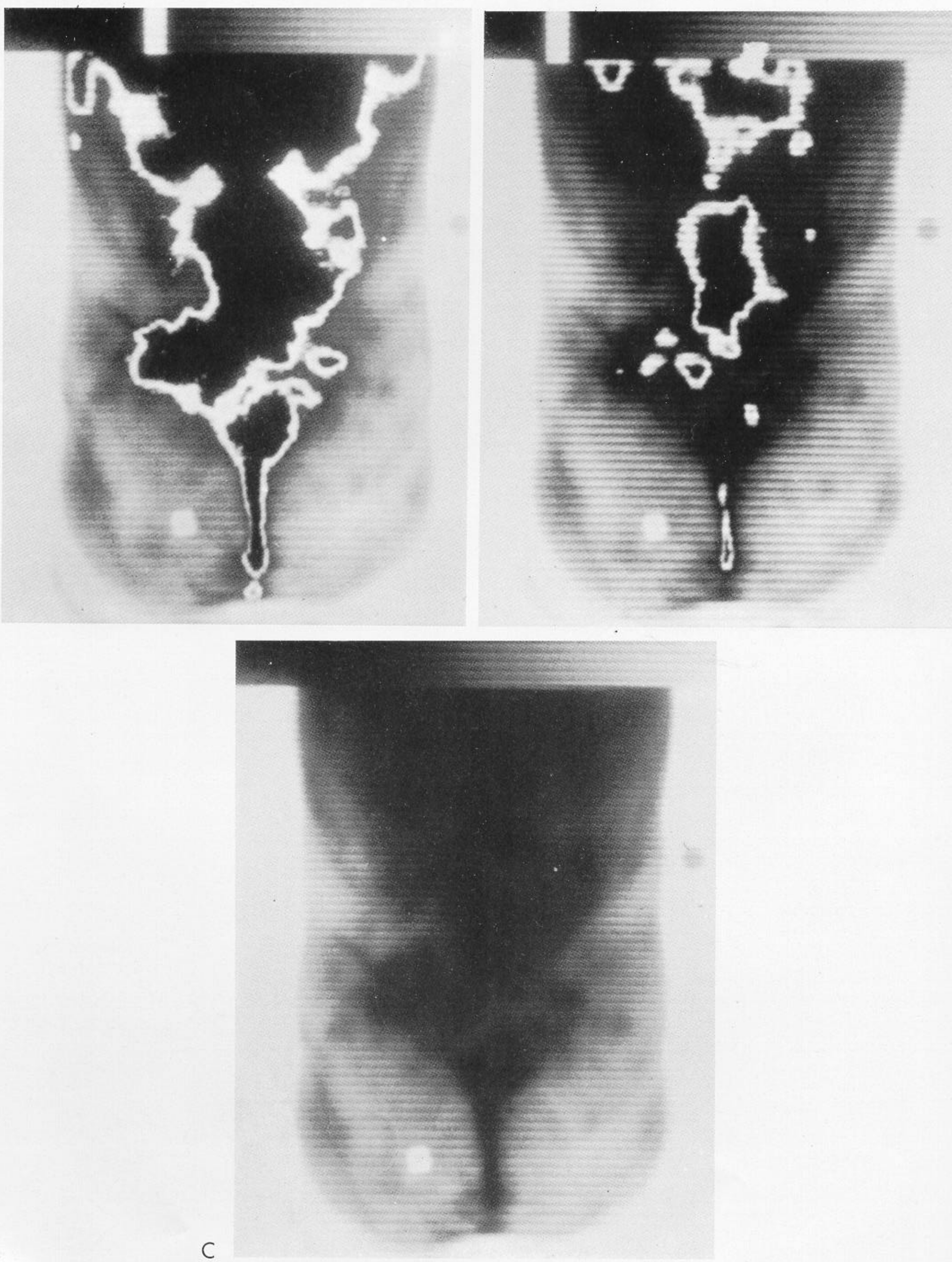


E F

G H

Fig. 5 E-F-G-H.

A



C

Fig. 6 A-B-C.

of the sacroiliac **region** of a normal subject. The isotherms shows that the lowest temperature was in the region of the buttocks and the highest temperature in the lumbar region. The temperature of sacroiliac region on the right and left side was the same.

Figure 6 is a thermogram of a male with ankylosing spondylitis. The isotherms shows a relatively high temperature over the sacroiliac joints and the asymmetry of temperature above the right and left side.

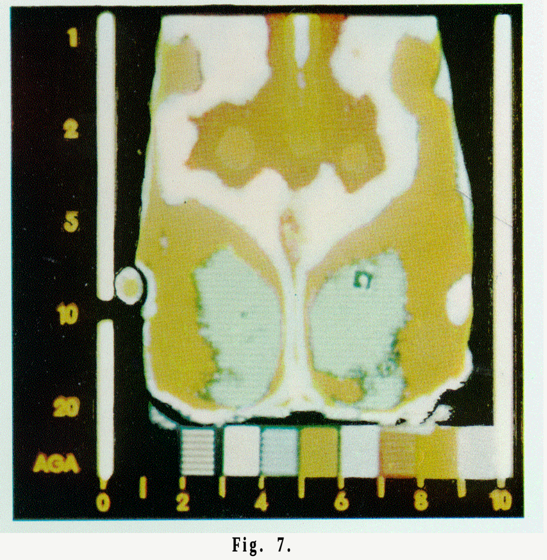


Fig. 7.

Figure 7 shows the lumbosacral region of an ankylosing spondylitis patient.

Figure 8 shows symmetry and raised temperature over the lumbar spine and sacroiliac region in an ankylosing spondylitis patient.

Figure Y shows asymmetric changes in the right and left sacroiliac region in an ankylosing spondylitis patient.

In some ankylosing spondylitis patients the scintillography with technetium 99 was performed. The ratio of isotope uptake of the sacroiliac joints and the middle of the tibia1 bone was calculated. A comparison of the results of both isotopic and thermographic examination showed a statistically significant correlation between the temperature over the sacroiliac region and the value of isotope index (Table V).

Tab. V. Correlation between tbermograpbic and radionuclide examinations of sacroiliac joints.

N. of joints	*Average temp. over sacroiliac joints*	*Average radio-rzuclide index*	*r*	*P*
30	*33*	*7,6*	*0,427*	*<0,05*

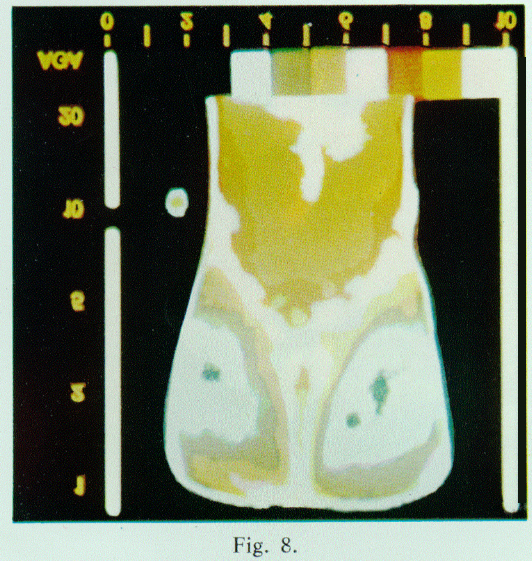


Fig. 8.

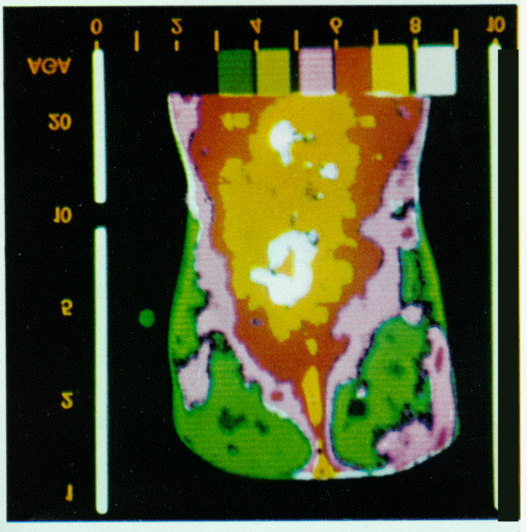


Fig. 9.

Conclusions

1. In healthy persons the curve obtained from the temperature of the lumbosacral region has characteristic and symmetric form.

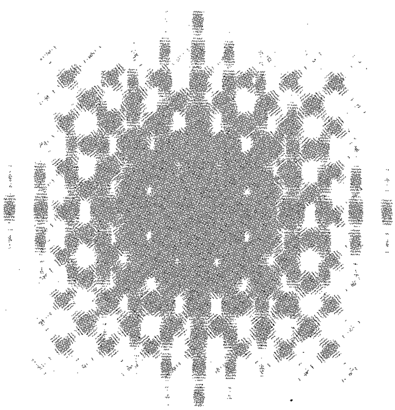
2. In ankylosing spondylitis patients the shape of the temperature curve in the lumbosacral region is different and often asymmetrical.

3. There are no statistically significant differences in the temperature of the lumbosacral region in ankylosing spondylitis patients and healthy persons.

4. Thermographic examination of sacro-iliac region is difficult and needs further study but may give some additional information for the evaluation of the disease.

REFERENCES

1. **Agarwal** A., **Lloyd K., Davey** P.: Thermography of the spine and sacro iliac joints in spondylitis. *Rheumafol. Phys. Med.,* 10, 349-*355, 1970.*
2. **Cosh** J. A., **Ring** E. F. J.: Techniques of heat detection used in the assessment of rheumatic diseases. *J. Radiol. Electrol., 48, 84-89,* 1967.
3. **Cosh** J, A., **Ring** E. F. J.: Thermography and rheumatology. *Rheumafol. Phys. Med.,* 10, 342-*347, 1970.*
4. **Sadowska-Wroblewska** M., **Kruszewski S., Filipowicz-Sosnowska** A., **Lee** W.: Assessment of thermography in the diagnosis of sacro-ileitis. *Rheumafologiu,* 13, 183-191, 1975.



4. Thermographic screening for scoliosis in adolescents

by R. E. Woodrough

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SUMMARY. An on-going study into the possible application of thermography as a screening technique for idiopathic scoliosis is discussed. Preliminary results are presented, describing tbermograpbic patterns observed in both an asymptomatic group, comprised of schoolchildren who took part in a pilot screening study, and a symptomatic group.
Temperature contours over normal backs form a characteristic Y with a high degree of symmetry about the spine. In the obese the Y pattern is often found to develop into a *patterns, but symmetry is maintained. In patients suffering from scoliosis the thermographic symmetry is destroyed, and skin on the concave side of the curve is found to be raised in temperature. A particularly important observation is a marked asymmetry in anterior thermograms of scoliosis patients.

Key words: thermography; scoliosis.

Introduction

The possibility of thermographic screening for adolescent idiopathic scoliosis is being studied by the Thermography Unit at Saint Bartholomew's Hospital.

Adolescent idiopathic scoliosis is a distressing condition mainly affecting girls and describes a lateral curvature of the spine. It affects the lumbar and thpracic portions of the spine and occurs in otherwise normal, healthy children. Often the curve is associated with a rotation, and the spine can deteriorate seriously within a few years of the initial observation.

The aetiology of scoliosis has been discussed by James [1]. In boys, the age of onset is mainly within the first years of life, and when occuring in the first 3 years is termed infantile. Juvenile scoliosis is said to occur between the ages of 4 and 9 years, and adolescent idiopathic scoliosis is used for the 10 + age group. The incidence of adolescent idiopathic scoliosis peaks at about 14 years of age. However, these divisions are not merely convenient categories for the age of onset.

In infantile idiopathic scoliosis the curve is eight or nine times more common to the left, but in adolescence the curve is eight or nine times more common to the right. The following procedure is experimental, and the findings are preliminary. However it is hoped that thermography may prove to be of clinical value as more experience is gained.

Procedure for thermographic examination of the back

The procedure used is based upon the recommended procedure for the A-D study group (to be published). For thermography of the back, patients are asked to undress completely, and long hair is tied up. Equilibration in the standing position is preferred to sitting. If the patient must be seated, then the back should not touch any supporting surface. Lateral views have not been recorded so the arms are allowed to rest at the side of the body. Measurement, is carried out in a room at 19 ± l°C, after a 15 minute equilibration period. Care is taken to ensure that the patient's skin is free from oils and ointments. Cosmetics, particularly talcum powder, are commonly used by adolescent girls.

The examination is carried out using an AGA 680 medical thermographic camera with a 15° X 15° lens. Thermogram5 are taken with the patient standing, arm5 resting by the side of the body. A temperature calibration source set at 32” C is included in the field of view, and a IO-colour isothermogram is recorded by photographing the image displayed on an AGA colour monitor. Temperature sensitivity of 0.5°C per colour was generally used, but on occasions thermal asymmetry can be more obvious using 1°C per colour. Monochromatic thermogram5 are also of value for displaying the locus of local maxima, and we routinely take monochromatic thermograms to accompany colour isothermograms.

Screening study

66 boys and 47 girls have been examined on site at a large London comprehensive school in an effort to examine the feasibility of a school screening programme. The described procedure was found suitable for a mass screening programme, although the equilibration time was reduced to 10 minutes due to the numbers involved: 113 examinations in three days. Very few problems were experienced due to inadequate cooling.

Thermographic patterns of the back

To date, six types of thermographic patterns have been recorded. These do not include sacro-iliac disease, or localised pattern5 due to spinal injury or metastases.

The normal thermographic pattern is characterized by a Y-shape, the high temperature over the vertebral column fanning out in the interscapular region (Fig. 1). A variation of the Y pattern which is sometimes seen is the V pattern, illustrated in Figure 2. In the obese, this pattern is modified to the Y-shape, illustrated in Figure 3. Idiopathic scoliosis seems to be commonly associated with an area of increased temperature on

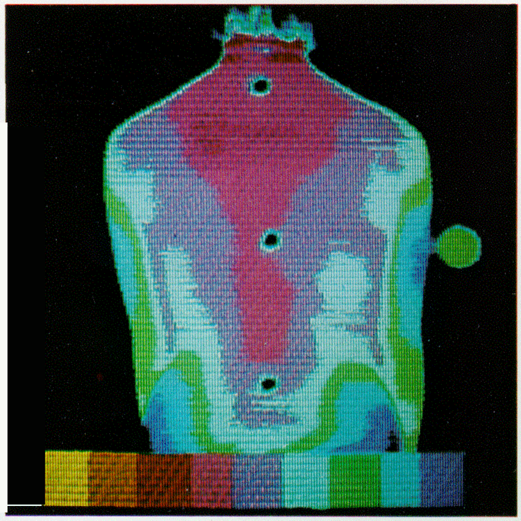

Fig. 1. Typical colour isothermogram of the Y pattern associated with normals. Sensitivity 1 °C/ colour. Temperature reference = 32 “C.

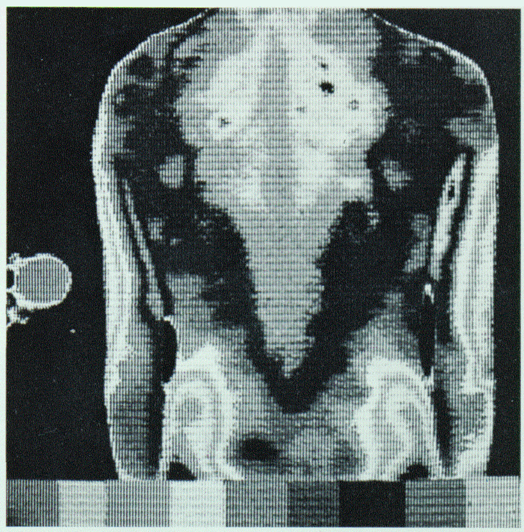

Fig. 2. Monochrome print of a colour isothermogram showing the V pattern, believed to be a normal variation of the Y pattern. Sensitivity 0.5°C/ colour. Temperature reference = 32 °C.

the concave side of the curve (Fig. 4). In a symptomatic group, thermographic patterns have been found similar to the pattern reported by Abernathy, Ronan and Winsor[2] resulting from coarctation of the aorta (Fig. 5). The sixth pattern, observed during the

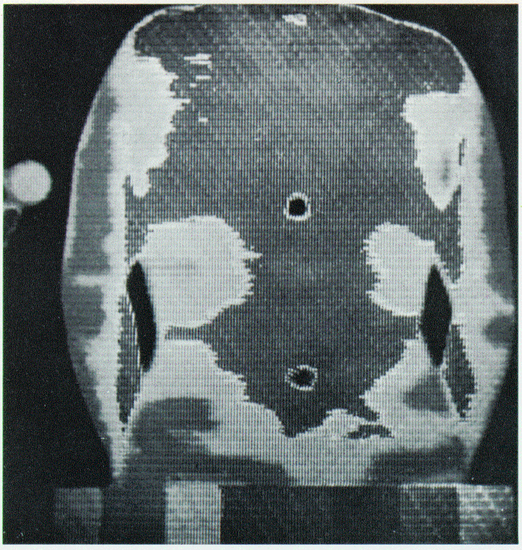

Fig. 3. Monochrome print of a colour isothermogram illustrating the effect of obesity on the norma1 thermographic pattern. Sensitivity 1°C/colour. Temperature reference = 32 °C.

Fig. 5. Monochrome print of' a colour isothermogram illustrating the ↑ pattern. Sensitivity 0.5 °C/colour. Temperature refcrcncc = 32 °C.

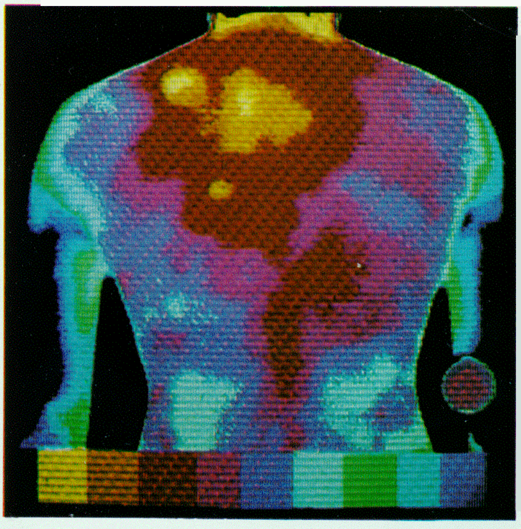

Fig. 4. Colour isothermogram showing the basic Y6 pattern associated with adolescent idiopathic scoliosis. Sensitivity 0.5 °C/colour. Temperature reference = 32 °C.

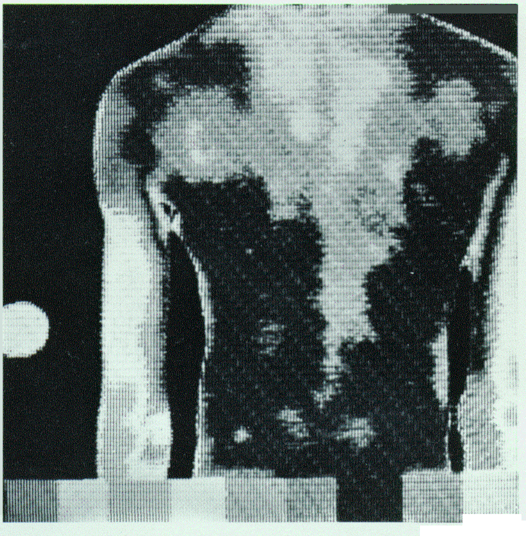

Fig. 6. Monochrome print of a colour isothermogram illustrating the Y| pattern. Sensitivity 0.5 °C/colour. Temperature reference = 32 °C.

screening survey, is a Y| which represents a band of increased temperature running down one side of the spine (Fig. 6), the significance of which is yet undecided.

In addition a marked asymmetry of the anterior view in scoliosis patients has been found (Fig. 7). but this also awaits further study.

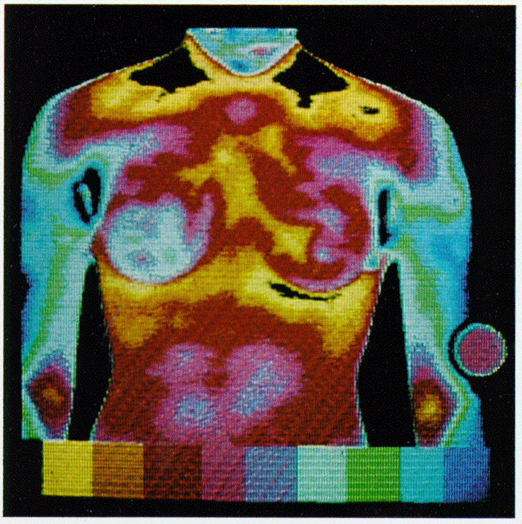

Fig. 7. Colour isothermogram illustrating the marked aaymmetry of anterior thermograms caused by scoliosis. Sensitivity 0.5 °C/ colour. Temperaturc reference = 32°C.

Future directions

Much further work remais to be carried out and the school screening study analysis will raise even more questions. It is not known to what extent abnormal patterns can be expected in a normal population or to what degree thermal asymmetry correlate with disease activity. Nor is it certain whether the pattern remains after the spine has stabilized. Serial examinations of both the symptomatic group and the asymptomatic group, may possibly answer some of these questions and lead to an understanding of the cause of the thermal asymmetry.

Thermographic examination of the back, as with all thermographic examinations, can involve several different clinical specializations, but the thermal patterns may carry a great deal of information which demands further exploration.

REFERENCES

1. JAMES J. I. P.: The aetiology of scoliosis, Chapter 20 in: ***Scoliosis*** and ***Muscle,*** Proceedings of 4th Symposium. Ed. P. A. **Zorab.** Spastics International Medical Publications Research Monograph No. 4. William Heinemann Medical Books Ltd. London (1974).
2. ABERNATHY M. R., RONAN J. A., WINSOR D. T.: Diagnosis of coarctation of the aorta by infrared thermography. ***American Heart Journal, 82, 731-741. 1971.***

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5. Thermographic evaluation of calcitonin therapy in Paget's disease of the tibia

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SUMMAKY. Calcitonin has been recently introduced for the treatment of Paget's disease. Clinical assessment of therapeutic agents is difficult, as most parameters of investigation change very slowly. Thermography is able to demonstrate changes in surface temperature where an underlying pathological process is causing a vascular or metabolic disturbance. The tibia is a particularly suitable site for thermographic evaluation of Paget's disease, and the effects of treatment. A mini-computer was used to analyse the data, comparing normal and raised values from six equal areas over the tibia1 surface. The preliminary findings from four patients are shown. Each patient was receiving intermittent calcitonin therapy. Two forms of the drug are being studied, a porcine and a salmon extract. Results so far indicate that thermography used in this way is a sensitive and convenient method of assessing Paget's disease. It is a powerful research tool for the evaluation of therapeutic compounds active against the disease. An acceptable and economic treatment regime should be safely achieved by regular monitoring of those patients in need of long term therapy.

Key words: thermography; Paget's disease; calcitonin therapy; thermographic index.

Introduction

Paget's disease of the bone effects the vertebrae, pelvis, femur, tibia and skull. It is characterized by phases of destruction and repair. Destructive lesions in the long bones are usually clearly defined areas surrounded by healthy bone. The destructive phase is though to be an early manifestation of the active disease, followed by progressive bone repair. The new bone formation leads to sclerosis, expansion, and coarsening of the trebeculae. Complications of this disease include compression fractures, and osteosarcoma. Deformity is frequently seen due to bone softening especially in the weight bearing tibia and femur. The disease is poorly documented, difficulty to assess, and of unknown aetiology.

In recent years a number of agents have been used to treat Paget's disease, most have been used for inhibition of bone resorption, and have produced a temporary pain reduction. The most commonly used is Calcitonin an amino-acid extracted from pig thyroid [1,2]. The compound is administered by injection and continuous therapy is recommended. More recently a salmon extract has been successfully used. However withdrawal of treatment usually causes a relapse, hence the need for maintaining a minimum dose and deciding on the frequency of injection.

Methods of assessment are usually based on biochemical and radiological parameters. Serum alkaline phosphatase and urinary hydroxyproline excretion are most frequently reported. The latter is less convenient, requiring 24 hour urine samples and certain dietary restrictions. Radiological change is slow, it may be six months before changes are established. Isotope scans are more sensitive to the changes in the disease process.

Thermography has been used as a non invasive method of assessment of Paget's disease of the tibia. The bone lies close to the anterior surface temperature of the skin in that area. The simplicity of the examination procedure allows frequent investigations to be made with maximum co-operation from the patient.

This paper is a preliminary report of an ongoing study to examine the use of a thermographic index as a means of assessing disease activity, and dose regime for individual patients with Paget's disease affecting the tibia.

Little is known of changes in the distribution of the disease, on and off treatment, and the presence of metabolic foci. The present study was designed to made a simple comparison of the distribution of heat over the tibia in a selected number of cases.

Technique

Rigid control of thermographic technique was maintained, which is essential for serial quantitative studies.

The patients are cooled in a room at 20°C with both legs uncovered for 15 minutes. They are then seated on a chair facing the thermograph with both feet on a low stool. As far as possible the legs are placed 10 cms apart with the tibia in a vertical position. A thermographic scan is made in 0.5 seconds with a reference temperature source set at 34.5°C. The picture is displayed in colour isotherms on a video system, and a standard region of interest selected by an on line minicomputer[4]. The area taken for measurement is a rectangle 25 cm X 5 cm wide, and is taken with the upper limit at the tuberosity of the tibia.

Reproducibility of this area is good, but changes in the degree of bowing of the tibia if present, is a limitation of the method. Other affected sites are less easily demonstrated, although the forehead and lumbar spine can produce abnormal thermographic patterns. From the area selected 500 counts are made by the computer and the temperature of each count printed out.

To facilitate analysis at a later date each printout was stored on punched paper tape. The thermographic index described by Collins and others was recorded on a temperature scale of 28.0-34.5. This index is based on calculation of isotherm areas and distri-

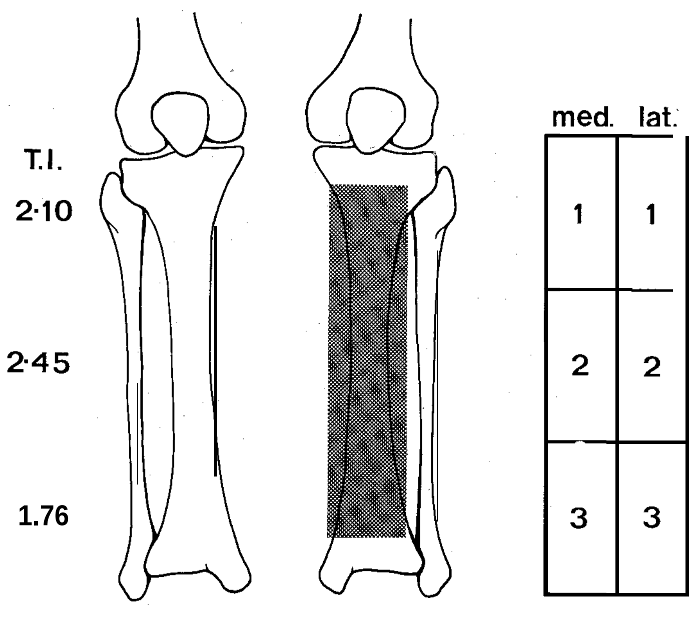
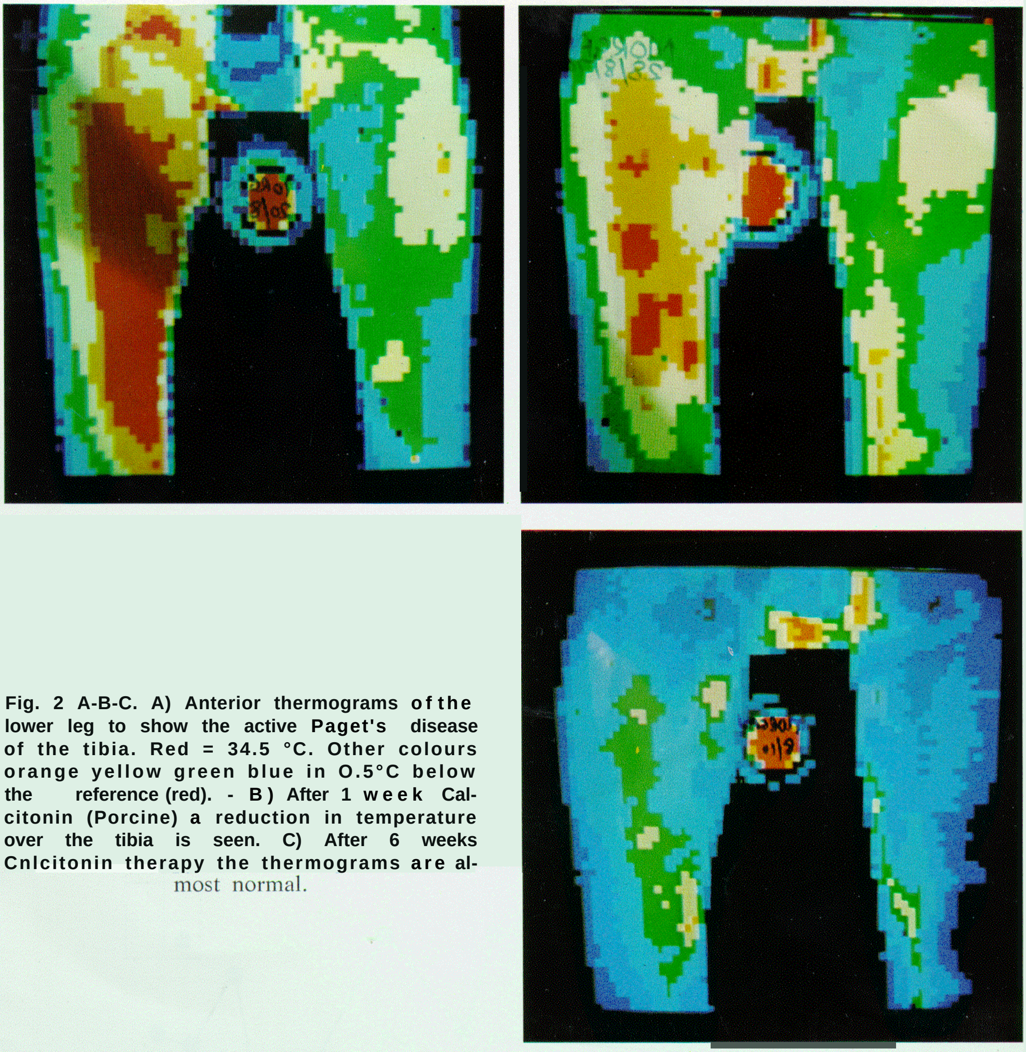


Fig. 1. The area of thermogram quantitated showing (right) the six equal areas and (left) normal values for thermographic index at three levels, obtained from 36 thermograms in a temperature range 28-35 °C.



A B C

Fig. 2 A-B-C. A) Anterior thermograms of the lower leg to show the active Paget's disease of the tibia. Red = 34.5 °C. Other colours orange yellow green blue in 0.5°C below the reference (red). - B) After 1 week Calcitonin (Porcine) a reduction in temperature over the tibia is seen. C) After 6 weeks Cnlcitonin therapy the thermograms are almost normal.

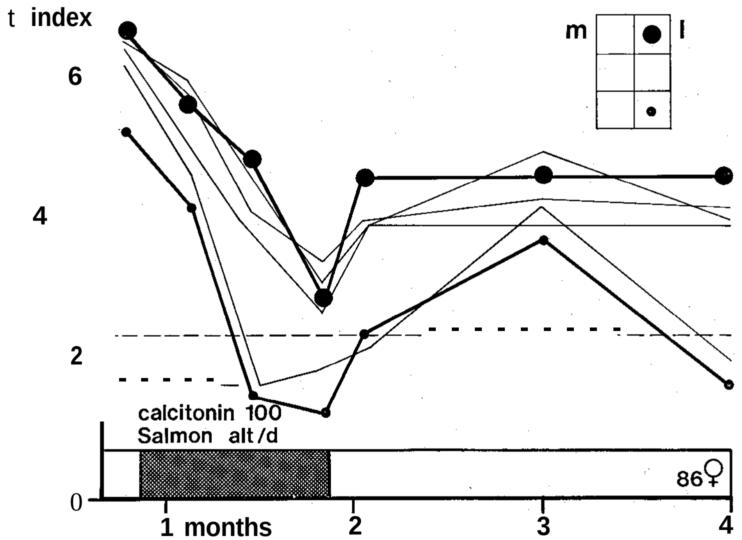
bution within a defined region of a thermogram. Normal values are low 2.0 and abnormal up to 6.0.

Results

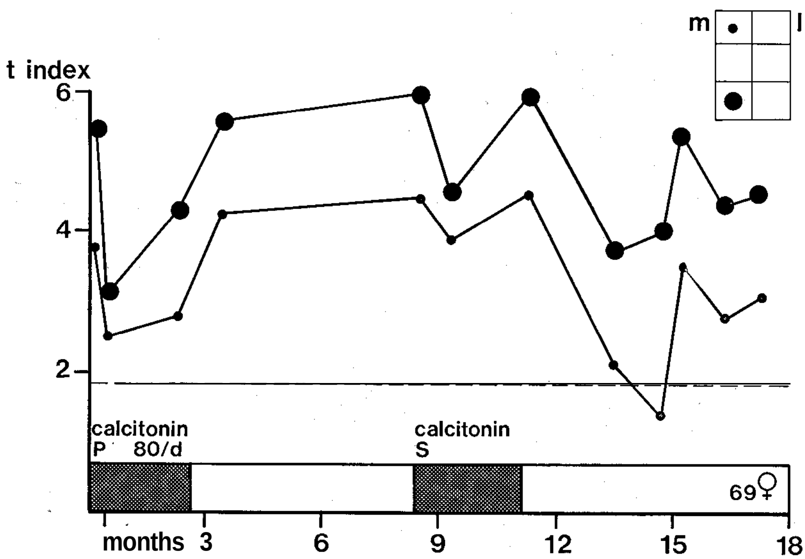
Nine normal subjects aged 20-40 years were examined by thermography and scans of the anterior surface of both tibia recorded.

Four patients with active Paget's disease involving the tibiae were examined over a period of up to 1½ years. All four patients were given periods of treatment with either porcine, or salmon calcitonin.

The area selected for analysis in both the normal and diseased tibia was divided into six equal rectangular areas (Fig. 1). The thermographic index (TI)[4,5], was recorded in the normals and the values from both left and right legs compared using the student t. test. The results showed that there was no significant difference (p=O.6). The left and right TI values were combined to obtain the mean for each area. The values for the six areas from each patient with Paget's disease were plotted. In each case a fall in temperature was shown very rapidly after onset of treatment by calcitonin (Graph 1, 2, 3, 4). In some cases this change could be detected in 7 days, occuring before clinical or biochemical evidence of remission (Fig. 2a,



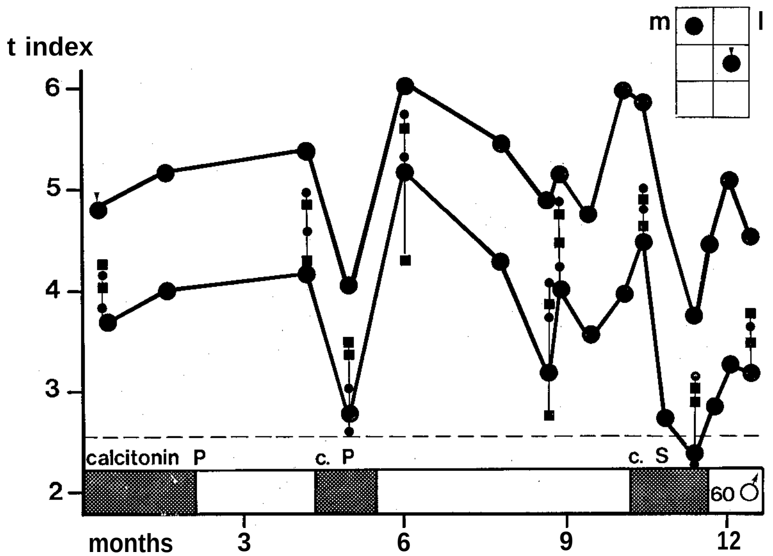
Graph. 1. Case 1. 86 years old female with Paget's disease. The thermographic index plotted from six equal areas from the tibia1 thermogram. The hottest is shown as • - • a n d the coldest as •-• The index falls during treatment with Salmon Calcitonin 100 MRC units given on alternate days.



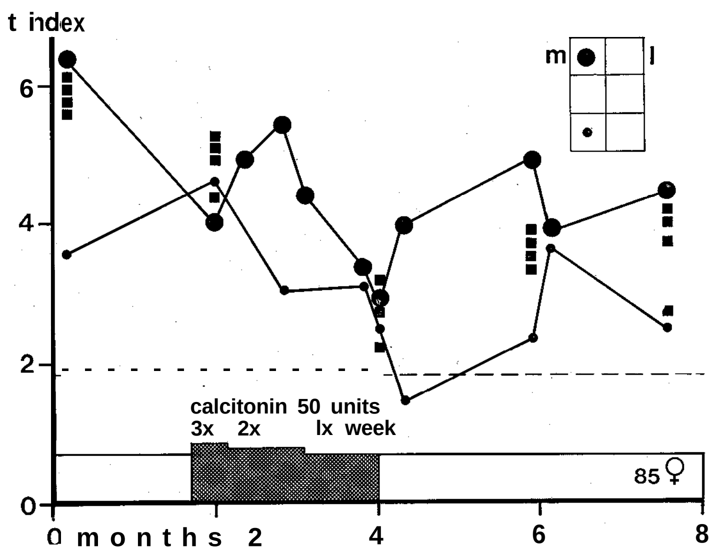
Graph. 2. Case 2. A female patient with Paget's disease. Thermographic indeces from the hottest and the coldest areas of the tibia1 thermogram recorded to show the effect of Porcine and Salmon Calcitonin therapy.

b, c). Similarly a continuous increase in the TI occured in advance of the other parameters during the period of relapse, when treatment had been discontinued. Each of the four patients with the disease exhibited a focus increased heat, in a different area of the bone.

This focus remained the hottest area both



Graph. 3. Case 3. The maximum and minimum thermographic indeces from a tibia1 thermogram of a male patient with Paget's disease treated with Porcine (P) and Salmon (S) Calcitonin. The small squares and points show the index of the other four areas of the thermogram.



Graph. 4. Case 4. Maximum and minimum thermographic indices from a patient with Paget's disease of the tibia. The effect of reducing doses of Salmon Calcitonin is seen to depress the hot focus of the diseased bone temporarily. This focus increased when therapy is stopped although the coldest continues to fall.

on and off treatment. In the cases illustrated treatment did not reduce the TI to the normal value in the focal area. Further work, which will include the comparison with clinical and biochemical studies will form the subject of a separate communication.

In a study such as this it is not only feasible to determine the effective dose of the drug but to determine the anticipated frequency of maintenance dosage (Graph 4). Calcitonin is very expensive, and the recommended daily injection, limits its use both for financial and convenience reasons. Resistance to porcine calcitonin therapy has been reported, after long term administration. It is not yet known if this is an immune antibody reaction or compensating parathyroid hormone secretion. Salmon calcitonin is more potent and needs more clinical evaluation. It is clear that thermography can be used to demonstrate metabolic changes within the tibia, and enable the more economic and efficient use of long term therapy[6].

REFERENCES

1. BELL N.H., AVERY S., JOHNSTON C.: Effects of calcitonin in Paget's disease and polyostotic fibrous dysplasia. *J. Clin. Endocrin.*, 31, *283-290, 1970.*
2. HADDAD J. G., BIRGE S. J., AVIOLI L. V.: Effects of prolonged thyrocalcitonin administration on Paget's disease of bone. New *Engl. Jour. Med., 283, 549-555, 1970.*
3. RING E. F. J., COLLINS A. J., BACON P. A.: Computerised thermography of peripheral joints (in press).
4. COLLINS A. J., RING E. F. J., COSH J. A., BACON P. A.: Quantitation of thermography in arthritis using multi isothermal analysis. I. The Thermographic Index. *Ann. Rkeum. Dis., 33,* 113-115, 1974.
5. RING E. F. J.: Thermography and rheumatic diseases, in: *Thermography,* Bibliotheca Radiologica, No. 6. Karger (Basel) 97-106, 1975.
6. COLLINS A. J., RING E. F. J., BACON P. A., BROOKSHAW J.: Thermography and radiology. Complimentary methods for the study of inflammatory diseases. *Clinical Radiology, 27, 237-243, 1976.*

Acknowledgments

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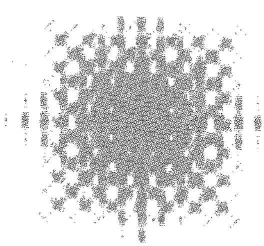


6. Anti-inflammatory drug assessment by the thermographic index

by A.J. COLLINS

Royal National Hospital for Rheumatic Diseases, Bath (England)

SUMMARY. Quantitative thermography is an ideal method to assess the response to anti-inflammatory or anti-rheumatic drug therapy in short and in long term drug trials. It is safe, reproductable and acceptable to the patient. It is totally objective. There must be rigid control of factors such as ambient temperature of the examination room, and patient cooling time. For large scale serial measurements, the process requires computer analysis of the thermograms.

Key words: thermography, rheumatoid arthritis, anti-inflammatory drugs, thermographic index.

The introduction of a new drug into clinical medicine requires extensive testing of the product, for efficacy of action and toxicity. Almost all countries have bodies like the British Committee for the Safety of Medicines, or the United States of America's Food and Drug Administration, through which such information must pass. It is most unusual for a new drug to be tested for effect or toxicity at the clinical level, without first being assessed in animal screening tests. To test drugs that are active against the chronic inflammatory diseases, and especially rheumatoid arthritis (RA) is difficult, because no satisfactory model of rheumatoid arthritis exists in animals.

Currently, great emphasis is being laid on finding non steroidal anti-inflammatory drugs active against the whole rheumatic phenomenon, rather than drugs with just anti-inflammatory action, and so drugs which are found to be active against even the best animal models of chronic inflammation may be less effective when used against RA. Often tests of drug efficacy are carried out using animals, with tests differing from those used clinically (Table I). For the clinical assessment of an anti-rheumatic drug a battery of tests are used which measure some aspect of the pathology of joint inflammation; size, some form of articular index, morning stiffness, grip strenght, and perhaps a pain score [6]. It is obvious that not all these criteria used clinically are available for measuring drug action in animals. A subjective analysis of a drugs potency by animal is unavailable, while a parameter such as joint size is more accurately measured in an animal than man. Few of the criteria used clinically are specific indicators of anti-inflammatory activity, for instance, measurements such as an increase in grip strength may be interpreted as a measure of

Tab. I. **Comparison of methods of assessment of anti-inflammatory drugs in clinical practise, and in animal models.**

Human	*Animal*
Joint size measure	yes
Articular index	yes
Morning stiffness	no
Subjective pain	no
Grip strength	no
Infra-red (thermography and radiometry)	yes
Often other complicating therapy	no
Various disease stages	no

analgesic action. An additional complication in the clinical assessment of a drug, especially in the rheumatic diseases, is that the subjects present in all stages of the history and activity of the disease. Animal models of inflammation are invariably used at a uniform stage of the lesion.

Two methods of indirectly measuring a fundamental parameter of inflammation have recently been developed. They are ^{133}Xenon (^{133}Xe) clearance from a joint[5], and measurement of the infra-red emission from a joint, by thermography. Both indirectly measure blood flow which is increased in joints affected by an inflammatory lesion, but of the two, thermography is non invasive and thus repeated studies may be carried out. Furthermore, it provides a valid measure in animals as well as man, and is a function which does not measure pain.

Measurement of inflammation by infra-red emission

Previously, E.F. J. Ring and I showed that in both animals and man, joint temperature did reflect other pathological events of inflammation, and that, in rats, the foot pad temperature of an inflamed limb decreased when the animals were given a non steroidal anti-inflammatory drug (N.S.A.I.D.) [3]. A simple experiment such as that shown in Fig. 1 illustrates this point. To measure the small areas of inflammation created in an animal, temperature measurement using a radiometer is adequate. However, when measuring the much larger areas of human joints a radiometer is not sufficient.

Measurement of joint inflammation by thermography

A thermogram of an inflamed joint measures not only the temperatures of the area, but also displays the distribution of the hyperaemic areas. This added information is most important when considering joint inflammation. Work carried out in Bath has shown that the thermogram of a joint affected by RA accurately shows the distribution of the hyperaemic synovial tissue which can be found when the joint is opened at operation (Fig. 2).

The thermographic index of inflammation

Simple qualitative description of joint inflammation is not sufficient for the measurement of anti-inflammatory drug action. A numerical measure is required, free from subjective error, and which responds to the anti-inflammatory action of drugs. Supra patella temperature, taken by radiometry, has been used to measure the effect of intra-articular anti-inflammatory steroid action in RA[2], but such spot temperature readings, unless taken in great number, and with great effort, do not display the complicated synovitis of a large human joint. Much more information about this state can be seen from a single colour thermogram, with isotherm temperature separation. Such a thermogram usually shows anatomical distribution of the synovitis, and includes all the inflamed areas in the thermogram that can be seen from a single aspect.

Quantitation of thermography

When a colour iso-thermogram of a joint is reduced to a single numerical figure, the result is a comprehensive measure of the total inflammation recorded in the whole picture, irrespective of the position of the synovitis.

A method of quantitation of colour iso-thermograms has been proposed by Collins et al.[4], and the resultant figure is referred to as the << Thermographic Index >> (TI). The TI is calculated from the expression:

$$\frac{\Sigma(\Delta t \times a)}{A}$$

where: At is the difference in °C from a base-line of 26°C, to each isotherm temperature; *a*, is the area occupied by an indi-

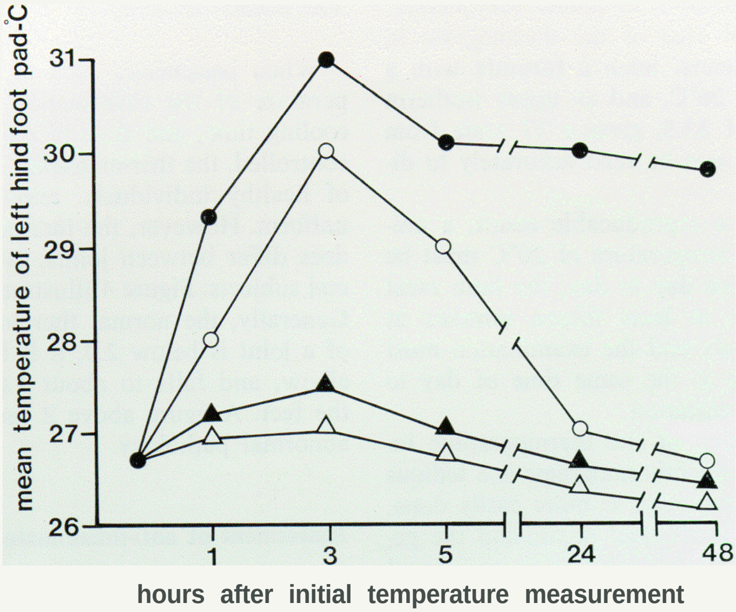


Fig. 1. The dose related anti-inflammatory effect of a non-steroidal anti-inflammatory drug (Azapropazone) measured by radiometry in rats. Inflammation was produced, in the left hind foot pad of Wister rats by the injection of 0.1 ml of a 1% solution of carageenin. The initial temperature of the feet was recorded immediately before the animals were given Azapropazone, orally at 50, O-O, 100, ▲—▲, and 200 mg/kg △—△. ●—● were controls

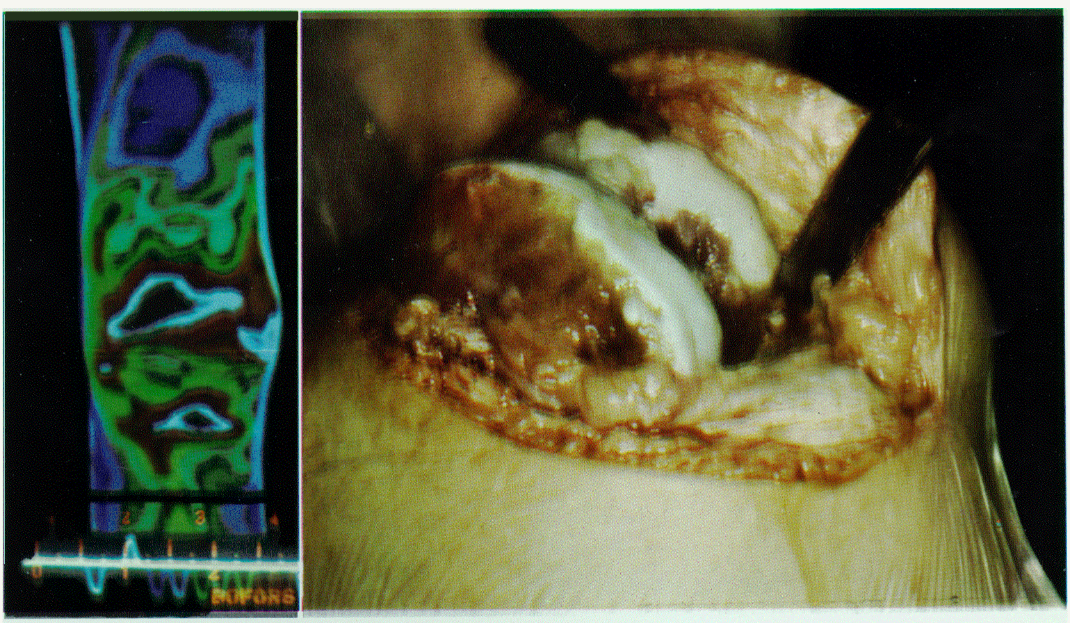


Fig 2. The thermograms of the right knee of a patient with synovitis due to rheumatoid arthritis. The operative findings showed a hyperaemic synovium encroaching into the femoral condyles. The leg is in flexor extension.

vidual isotherm area, in square centimeters; *A*, is the total area of the thermogram in square centimeters. Such a formula with a a base line of 26°C, and an upper isotherm temperature of 32.5, gives a TI scale from 1 to 6, which can be read accurately to divisions of 0.1.

To achieve a reproducable result, a uniform ambient temperature of 20°C must be maintained from day to day, the limb must be cooled for at least fifteen minutes at this temperature, and the examination must be carried out at the same time of day to avoid/ diurnal variation.

The generation of the thermographic index from colour isothermograms is a tedious procedure. The process is more easily done, by computing isothermal areas, and the general area of interest by taking the signal from the infra-red scanner, and processing the signal with a computer which re-synthesizes the picture on a colour television screen. Any region of interest of the thermogram may be chosen, by this method, and the areas of individual isotherms, and the total thermographic index calculated immediately. We use such a system, which utilizes a PDP8e computer, interfaced to the Bofors infra-red scanner (Fig. 3).

The normal thermographic index

When parameters such as, ambient temperature of the examination room, patient cooling time, and time of day are carefully controlled, the thermographic index of joints of healthy individuals, remain remarkably uniform. However, the thermographic index does differ between joints, even in the normal subjects. Figure 4 illustrates this finding. Generally, the normal thermographic index of a joint is below 2.0, it is highest for the elbow, and falls to about 1.0 for areas of the feet. A figure above 2 usually indicates abnormal pathology.

Assessment of anti-inflammatory drugs

1. Non steroidal anti-inflammatory compounds

There are a great many non steroidal ('aspirin-like') anti-infiammatory drugs used in the treatment of the rheumatic diseases. As well as possessing anti-inflammatory activity, these compounds usually have analgesic action, which confuses the results of many clinical tests used to detect their anti-inflammatory activity. A thermographic de-

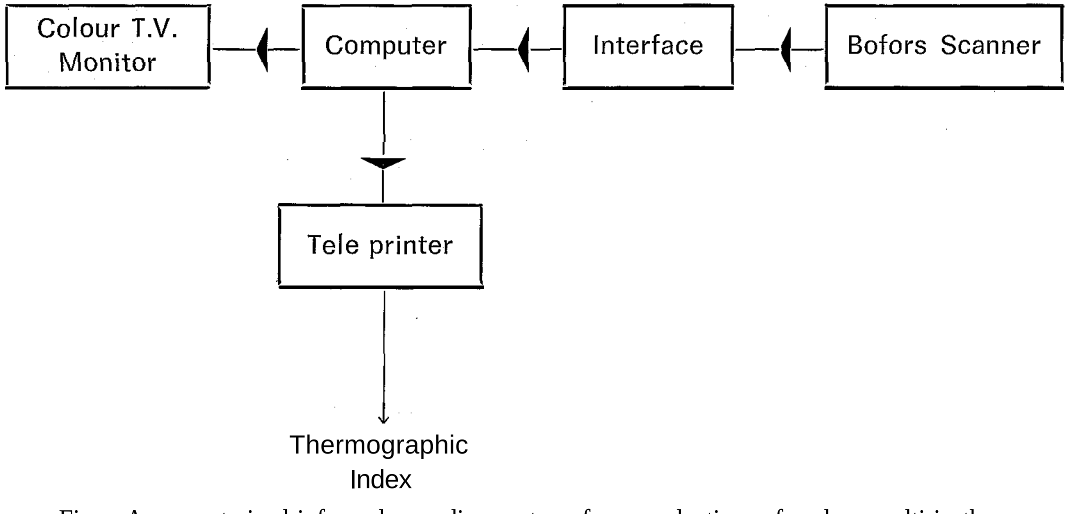


Fig. 3. A computerized infra-red recording system, for production of colour multi-isothermograms and the thermographic index.

termination of anti-inflammatory activity overcomes this problem. Adoption of a standard regime for open-blind study using thermography enables a comparison to be made of similar non-steroidal anti-inflammatory agents over a given time span. Patients with advanced rheumatoid arthritis are almost always taking some form of anti-inflamma-

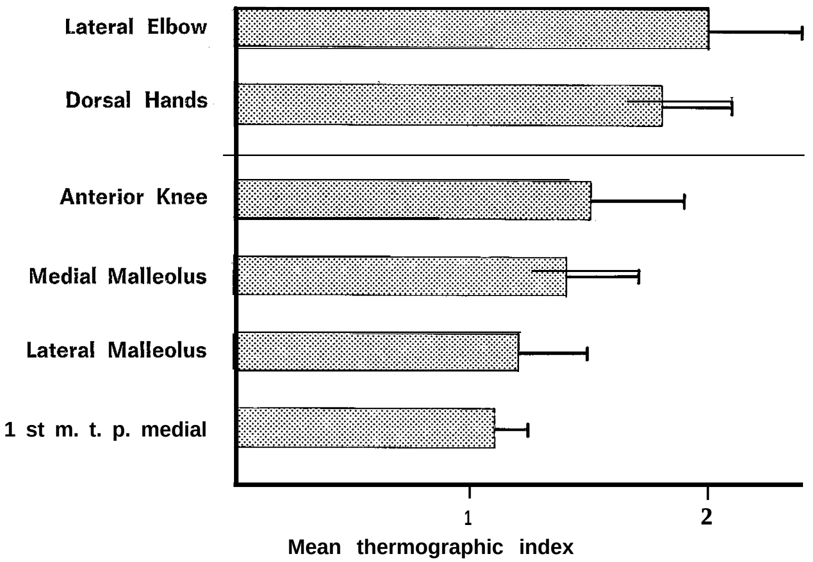


Fig. 4. The mean thermographic index of normal joints. Bars indicate the standard error of the mean:

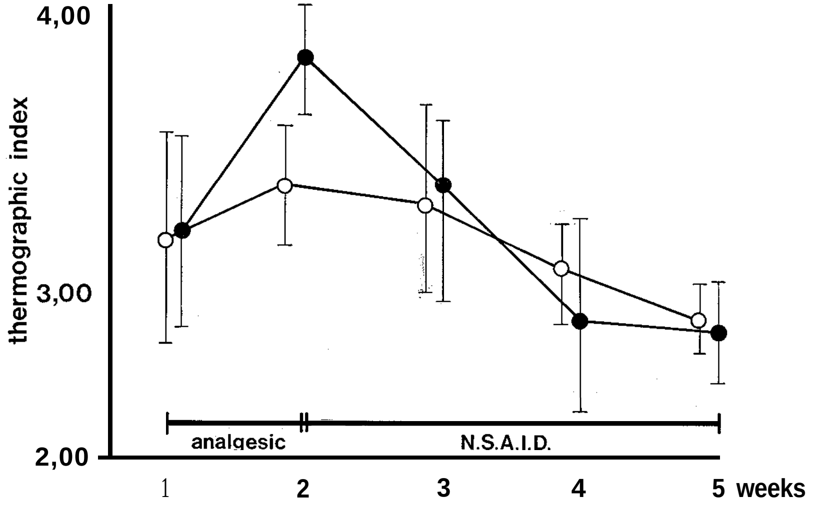


Fig. 5. The thermographic indices of the hands and knees of seven patients, with RA, measured over four weeks. During paracetamol therapy the index increased, the following three weeks of therapy on a non steroidal anti-inflammatory drug produced a fall in the index. The index for hands (•-•) deteriorated faster than the knees (O-O), during paracetamol therapy, and recovered faster during anti-inflammatory therapy. Bars indicate standard deviation.

tory drug. Thus, in this hospital we routinely give a seven days 'wash out' period on a pure analgesic agent, such as paracetamol. We then measure the fall brought about by a N.S.A.I.D. using the compound TI from up to four selected joints. The rate of fall in the TI caused by the test drug, and the extent of improvement of the inflammation can then be measured. The typical deterioration in the inflammatory state after paracetamol and improvement after an aspirin-like drug is shown (Fig. 5).

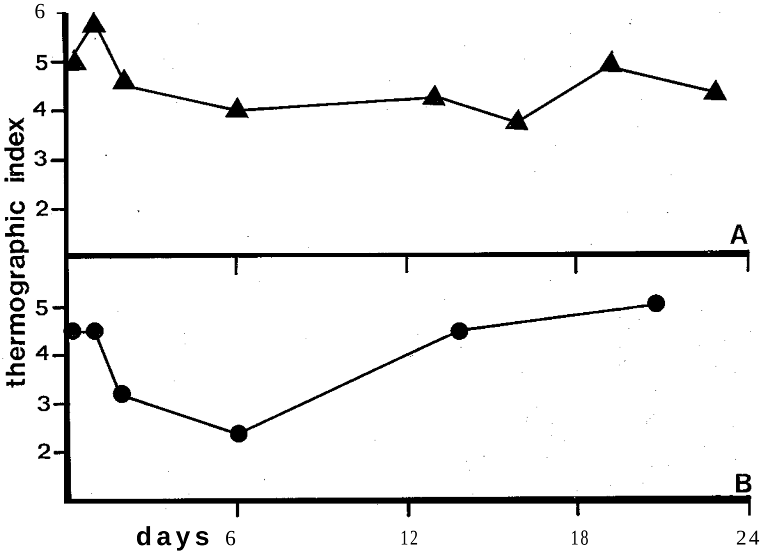


Fig. 6. The fall in the thermographic index, after a single intra-articular injection into two inflamed knees, of prednisolone tributyl acetate (Codelcortone) of 50 mg (A) and 100 mg (B).

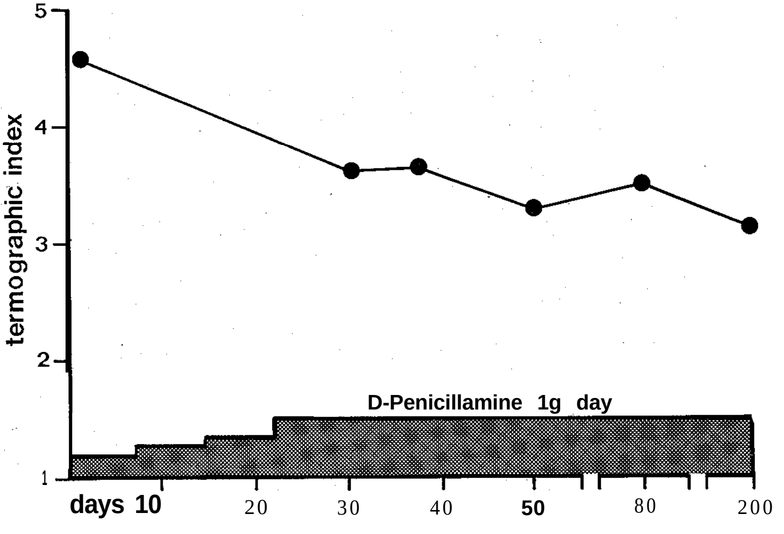


Fig. 7. The mean thermographic index of the hands and knees of a patient with RA, given increasing doses of D-penicillamine followed over 200 days. There was a slow improvement, shown by the steady, but unspectacular fall in the thermographic index, typical of this drug.

2. Intra-articular steroid injection

The anti-inflammatory response to intra-articular steroid injection has been well documented, and is useful as a demonstration of the TI response to this type of therapy [4,7]. Figure 6 shows the fall in the TI achieved by the intra-articular injection of prednisolone into the knee, at two doses.

A single injection of an anti-inflammatory steroid into an inflamed joint produces a fall in the TI, maximal within two to seven days. The duration of the improvement varies between subjects, but the joints usually revert to near the initial state by three weeks. The technique has been used to distinguish between chemical analogues of the same steroid used as an anti-inflammatory therapy for acute synovitis in RA.

3. Assessment of long-term anti rheumatic therapy

When the conditions for thermography are rigidly controlled, change in TI may be used to follow the patients response to long term treatment with drug such as penicillamine or cytotoxic agents. A study which compares two doses of penicillamine has been made in this hospital, covering a time span of up to one and a half years[1]. The relatively rapid response to high dose penicillamine suggests that this drug may have direct anti-inflammatory effect, in some situations (Fig. 7). The long term changes in the TI often occour before other changes in the clinical state of the patient are observed, both when the patient improves and deteriorates.

REFERENCES

1. **Bucknall** R. C., **Ring** E. F. **J.. Collins** A. J.. **Bacon P.** A.: A thermographic assessment of the anti-inflammatory effect of D-Penicillamine in rheumatoid arthritis. *Scand. Jour. Rheumaf.,* 4, (supple. 8) 21-29, 1975.
2. **Collins** A. J., **Cosh** J. A.: Temperature and biochemical studies of joint inflammation. *Ann. Rheum. Dis., 29, 386-392, 1970.*
3. **Collins** A. J., **Ring** E. F. J.: Measurement of inflammation in man and animals bv radiometry. *Brit. J. Pharmacol., 44,* 145-152: 1972.
4. **Collins** A. J.. **Ring** E. F. J., **Cosh J.** A., **Bacon** P. A.: Quantitation of thermography in arthritis using multiisothermal analysis. I. The thermographic index. *Ann. Rheum. Dis., 33,* **113-115, 1974.**
5. **Dick W. C., Grennan** D. M.: Radioisotopes in the study of normal and inflamed joints, in *Clinics in Rheumatic Diseases, 2, No. 1. 67-76,* 1976 Ed. M.I.V. Jayson W.B. Saunders Company Ltd., London, Philadelphia, Toronto.
6. **Huskisson** E. C.: Assessment for clinical trails, in: *Clinics in Rheumatic* Diseases, 2, No. 1. 37-49, 1976. Ed. M.I.V. Jayson, W.B. Saunders Company Ltd., London, Philadelphia, Toronto.
7. **Ring E. F. J., Collins A. J., Bacon P. A., Cosh** J. A.: Quantitation of thermography using multiisothermal analysis. II. Effect of non-steroidal anti-inflammatory therapy on the thermographic index. *Ann Rheum. Dis., 33, 353-356, 1974.*

7. Diagnosis of infected prepatellar bursa by thermography *(Case report)*

by H. A. Bird, and E. F. J. Ring

Royal National Hospital for Rheumatic Diseases, Bath (England)

In the differential diagnosis of the rheumatic diseases thermography offer5 a rapid and noninvasive method for the precise localization of an area of infection.

Case Report

Mr. L.S., age 42, developed a painful effusion in hi5 Ieft knee. There was no history of trauma or previous arthritis. The knee improved with rest and phenylbutazone but two weeks later it recurred. It again improved with an intra-articular injection of 20 mgm Depo-Medrome. Three weeks later he developed an acute arthritis of' the left knee and when pus was allegedly aspirated from the knee he was admitted to hospital.

Examination showed a hot tender knee, particularly over the patella but the joint

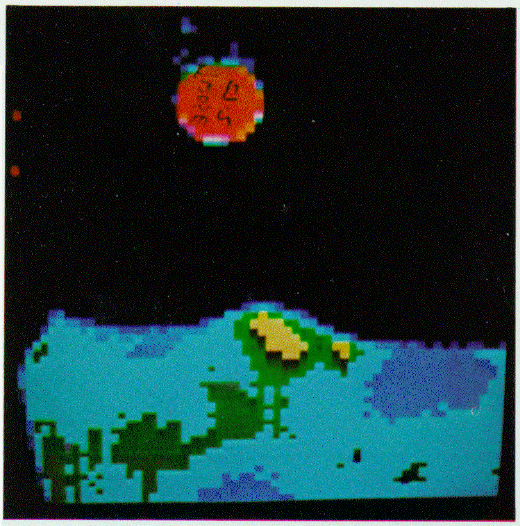


Fig. 2. Mrs. A. 7'. Non infected prepatellar bursitis.

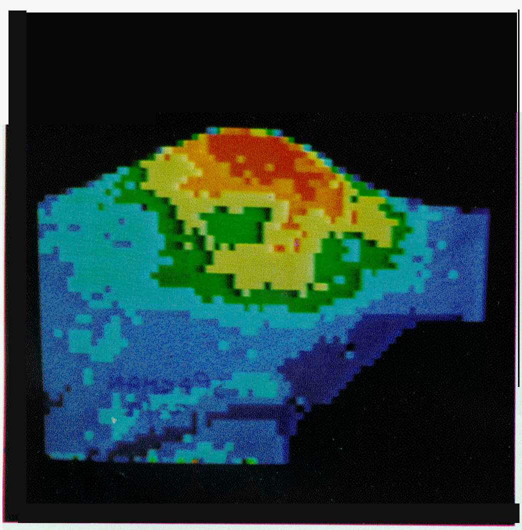


Fig. 1. *Mr. L. S.* Infected prepatellar bursa.

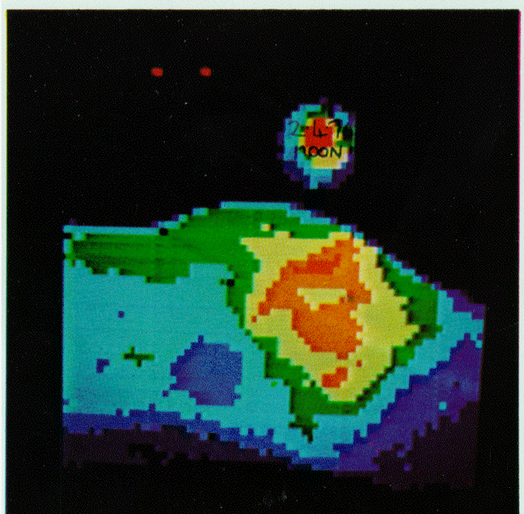


Fig. 3. *Mr. E. M.* Septic arthritis of knee.

line was not tender and there was no effusion in the knee joint. It was uncertain whether this was an infected knee joint or an infected prepatellar bursa.

A lateral thermogram was taken (Fig. 1) and comparison of this with thermograms from patients with a traumatic but non infected prepatellar bursitis (Mrs. A. T., Fig. 2) and a septic arthritis (Mr. E.M., Fig. 3) showed that this was an infected prepatellar bursa.

This diagnosis was confirmed by aspiration from -both the knee joint (no fluid obtained) and the prepatellar bursa (thick pus, white blood count 80,00O/ml with a profuse growth of Staph. Aureus on culture). The site of aspiration was confirmed by injecting Conray 280 contrast medium to both cavities (Fig. 4) showing evidence of infection and induration in the prepatellar bursa but no connection between the two cavities.

Treatment was started with systemic penicillin and daily aspiration, lavage and penicillin to the prepatellar bursa and the patient made a complete recovery.

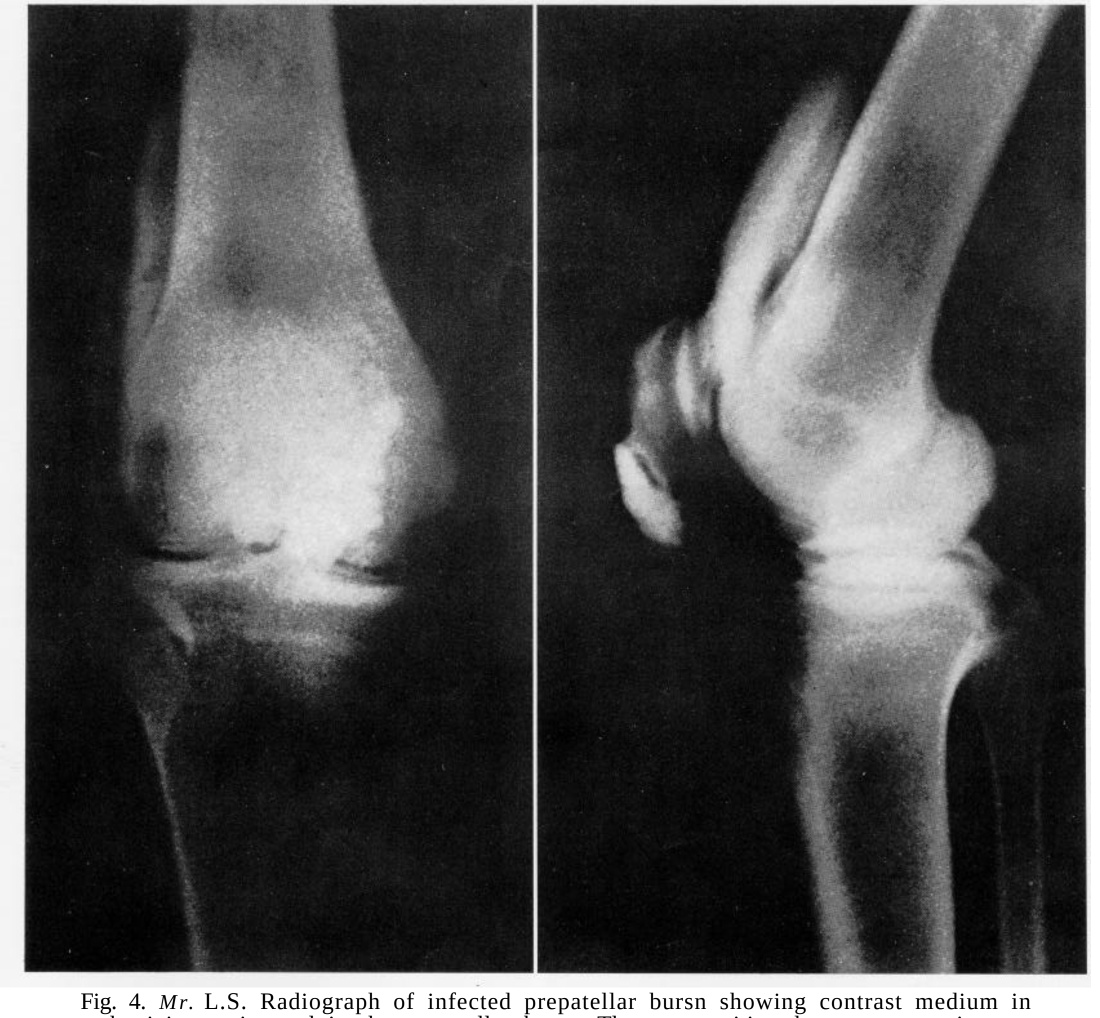
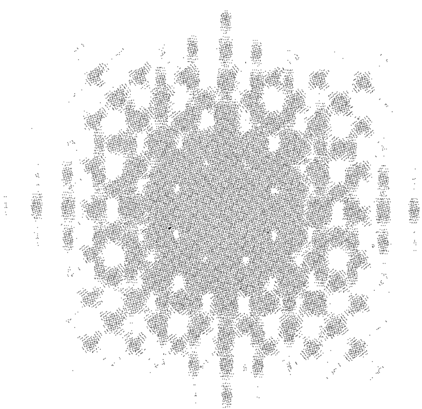


Fig. 4. *Mr.* L.S. Radiograph of infected prepatellar bursn showing contrast medium in the joint cavity and in the prepatellar bursa. The two cavities do not communicate.

Discussion

Although bacterial sepsis in a joint or bursa tends to emit more heat than Rheumatoid Arthritis at the same site there is such a wide overlap that thermography is of limited value in deciding the nature of the pathology. It is of more value in deciding the site of the pathology. In this case we were able to distinguish between infection in the prepatellar bursa and infection in the anterior compartment of the knee joint; two parallel tissue planes separated by about 2 cms. The technique is quick and non-invasive.



8. Rheumatoid arthritis - response to penicillamine therapy using thermography

(Case report)

by R. C. BLJCKNALL

Royal National Hospital for Rheumatic Diseases, Bath (England)

We have been using thermography to assess the response to D-Penicillamine in patients with active rheumatoid arthritis. The data from one patient is presented. This 50-year old builder was commenced on a dose of 250 mgs. daily, the dose being increased by increments of 250 mgs. daily each week so that after one month he received 1 G of D-Penicillamine daily (shaded areas of Figs. 1 and 2). This dose was maintained until four months after commencing therapy when he developed thrombocytopenia and the drug was abruptly discontinued, to be recommenced one month later in a dose of 150 mg. daily. The mean thermographic index (TI) of hands and knees was measured weekly for the first month and then at monthly intervals to six months. The change in thermographic index is shown in both Figs. 1 and 2 with clinical parameters of pain score (P.S.) and duration of morning stiffness (M.S.) in hours in Fig. 1. The plasma viscosity (P.V.) which is a measure of fibrinogen and immunoglobulin concentrations correlates to some extent with the E.S.R. and is shown in Fig. 2.

During the first month of therapy the TI increased inspite of some improvement in M.S. and P.S. This might represent the effects of physiotherapy as indicated by Dr.

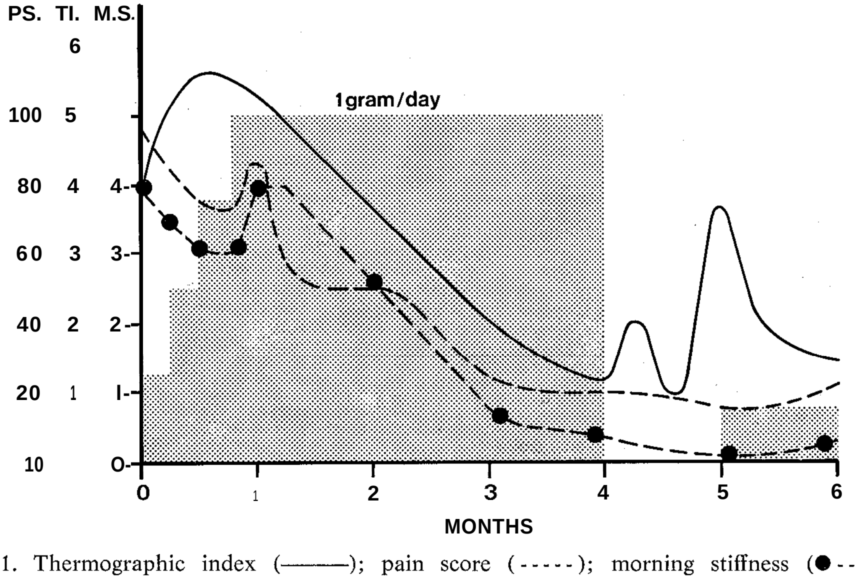


Fig. 1. Thermographic index (———); pain score (-----); morning stiffness (● - - - ●).

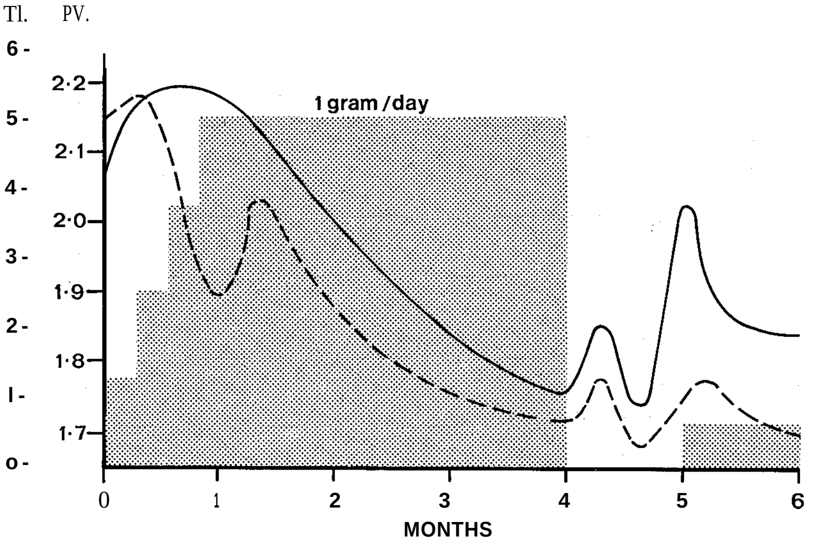


Fig. 2. Thermographic index (———); plasma viscosity (-----).

Tiselius in his paper. Between the second and fourth months there was a marked reduction in TI which correlated with an improvement in P.S., M.S. and P.V. However on withdrawal of D-Penicillamine at four months there was evidence of a rapid increase in inflammation as assessed thermographically and by the plasma viscosity, whereas the clinical parameters continued to show an improvement. Clinical evidence of increased activity of disease became evident two months after withdrawal of the drug.

These results suggest that the TI is a sensitive method of detecting changes in activity of disease and may precede clinical methods of assessment.

9. Temporo-mandibular arthritis (a rare diagnosis)

(Case report)

by P. F. G. M. VAN WAES, and D. SCHONFELD

Department of Roentgenology, University Hospital, Ulrecht (Netherlands)

Female, age 34, suffering from polyarticular rheumatoid arthritis during 2 years. Seronegative, ESR 37 mm/l hr, elevated total protein.

23.6.1975

X-hands: soft tissue swelling around proximal interphalangeal joint of dig. II r.

X-knees: no abnormalities.

Thermogram knees (Fig. 1): r. knee temp. 32-34” C, with hot spot on the patella. L. knee shows hot spots on medial and lateral aspects of knee, i.e. 33” C.

11.9.1975

Thermogram hands (Fig. 2): r. metacarpal 32” C with a temperature elevation in dig. II. L. hand slightly elevated temperature in the metacarpal regions.

10.2.1976

Thcrmogram hands (Fig. 2): changes emission pattern. R. metacarpal regions show a temperature of 30-32” C; dig. III 32-33” C and dig. II 28-29” C. These hot spots are marked on the profile scan.

Thermogram of mandibulur joints (Fig.

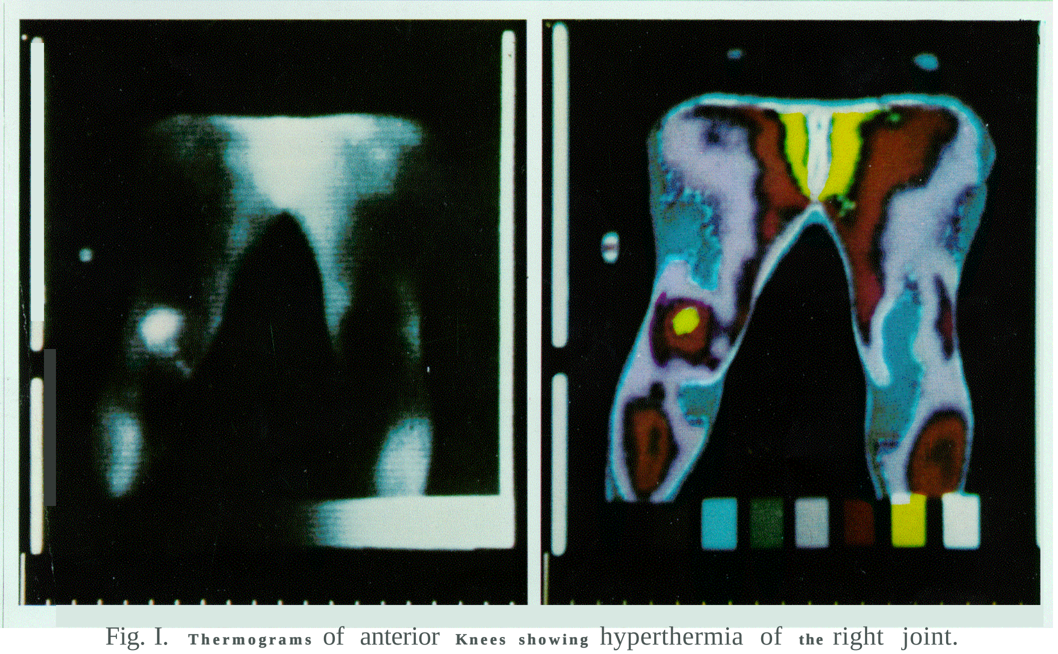


Fig. I. Thermograms of anterior Knees showing hyperthermia of the right joint.

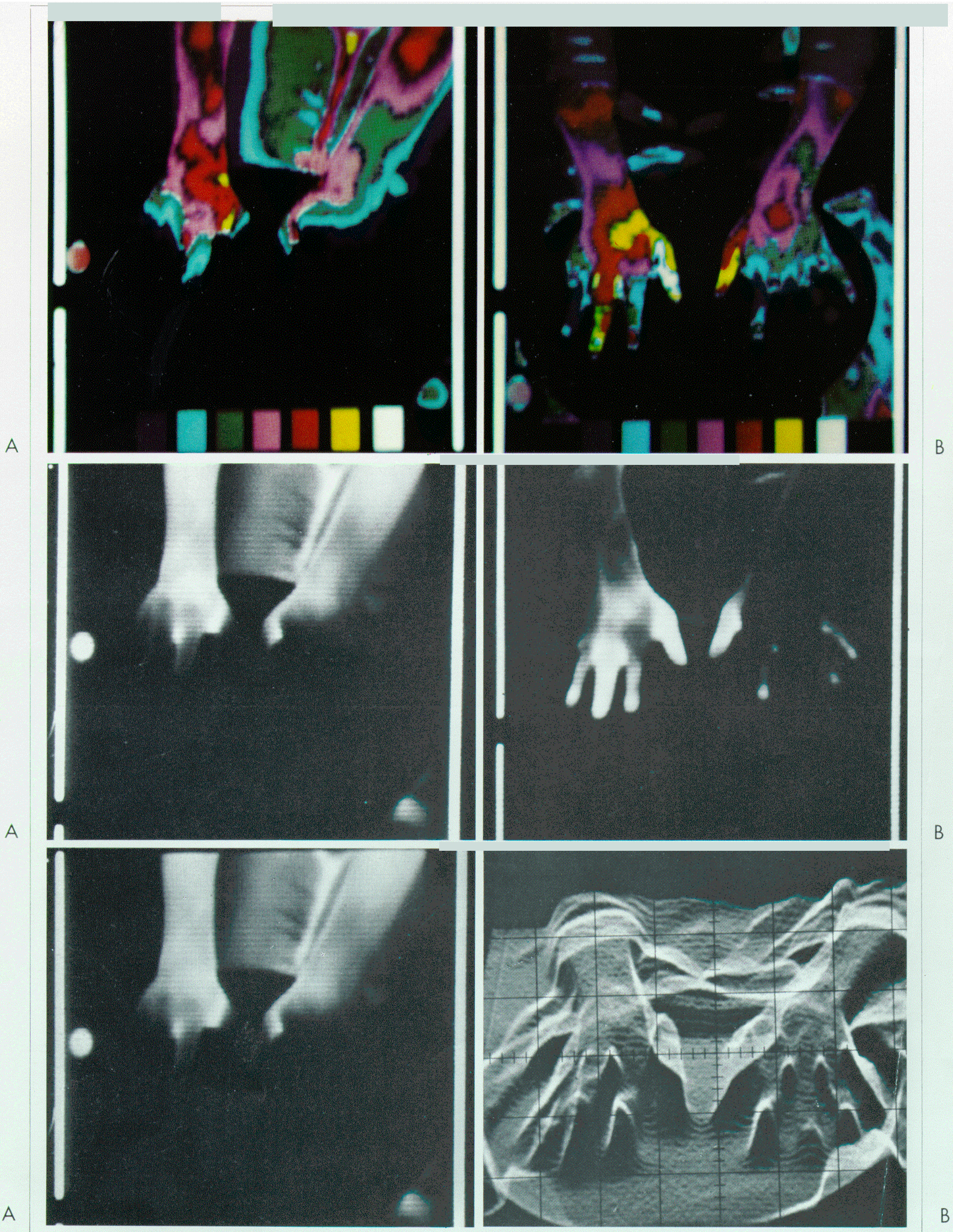


Fig. 2. A) Thermograms of hands; B) Changes emission pattern after six months.

R.

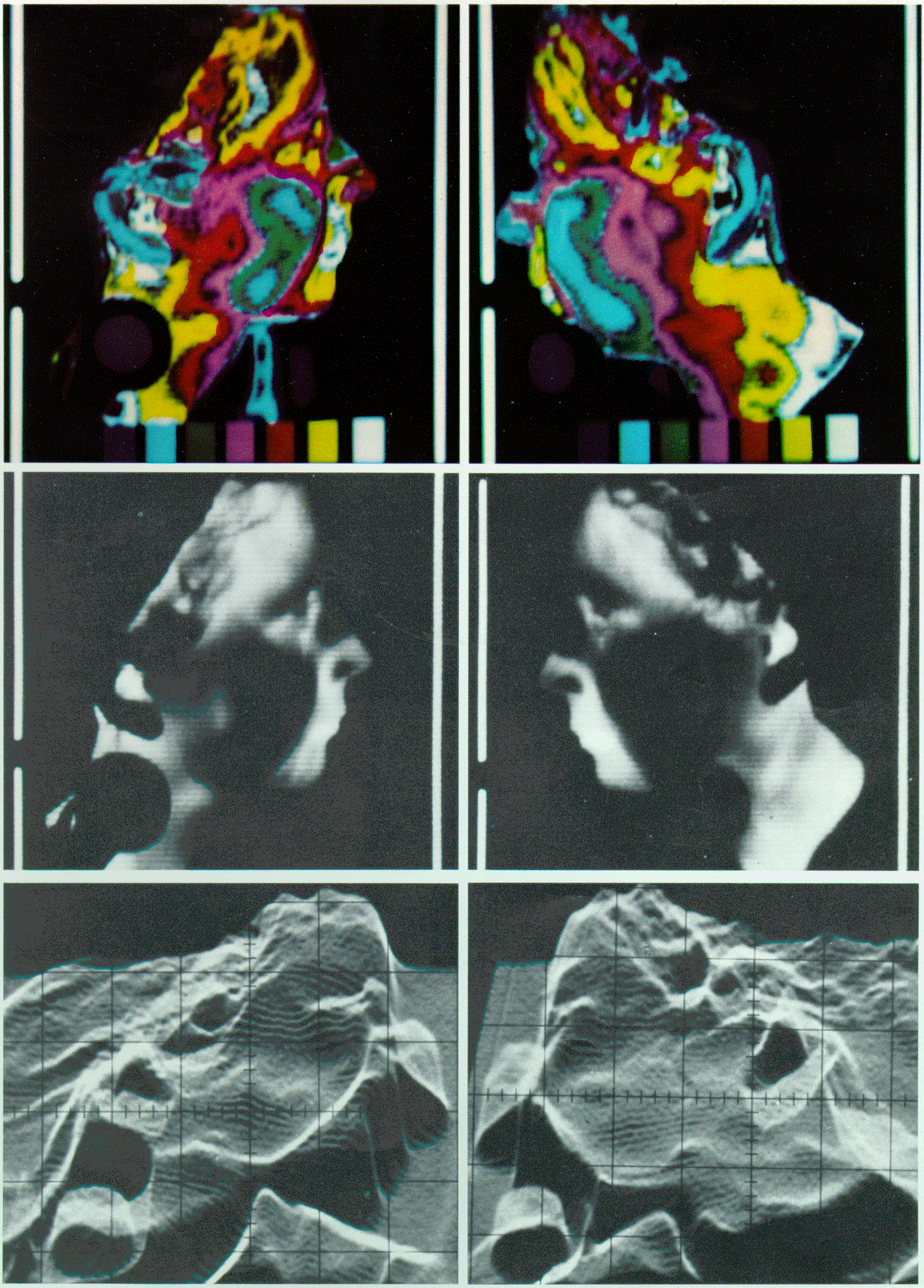
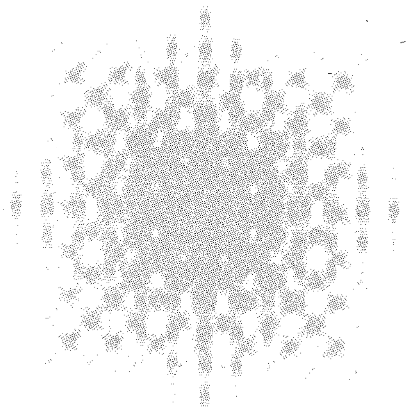


Fig. 3. Lateral thermograms face showing temporal mandibular hyperthermia of the left side.

3): from the end on 1974 increasing complaints about the 1. mandibular joint, Thermographs of the r. mandibular joint shows a normal pattern, with a temperature of 33” C. The 1. joint however shows a marked hot spot of 34-35” C.

Clinical diagnosis: pressure ulcus and articular dysfunction, possibly associated with an arthritis of bacterial origin due to a non-fitting dental prothesis. After correction of this prothesis there was rapid relief of pain and decreasing signs of arthritis.

Conclusion: thermography demostrated finally the serious nature of patients longstanding complaints. The rheumatoid aspects of this arthritis is still uncertain.



Value and interest of dynamic telethermography in detection of breast cancer

by R. Amalric, D. Giraud, C. Altschuler, J.M. Spitalier

Regional Cancer Center, Marseille (France)

SUMMARY. The authors have studied over than 3,000 microscopically proven breast tumours. From this material of study, they have verified the reliability of their classification into 5 categories. It shows that the rate of false-negatives (9%) and false-positives (9%) is acceptable.
Besides, telethermography used in a combined diagnosis outline (with physical examination, X-ray and cytology) enables to detect 9% of clinically or radiologically benign cancers, 9% of isotherm cancers with a good prognosis and 11% of fast growth cancers, the latter being of a very poor prognosis.

Key words: infra-red thermography, breast diseases, false-negative, false-positive, cancer detection.

To define the value of Dynamic Telethermography (D.T.T.) in breast diseases, we should first make a selection of the *objective measurable parameters* (Table I). It is then necessary to classify the mammary thermograms into categories of *growing diagnostic value* (Table II).

Table **I. Suspicious signs and malignancy criteria.**

Parameters	*Suspicious signs*	*Criteria of malignancy*
Hypervascularization	Asymmetric	Anarchic
Hot spot	***2,5 °C***	***23 °C***
Whole breast hyperthermia	2 °C	***>2 °C***
Edge sign	Localized	**Extended**

Table **II. Classification of mammary thermograms (Ref. 1, 2, 3 and 4).**

TH1	Normal thermogram
TH2	Thermogram of a benign type
TH3	Suspicious or doubtful thermogram (with one sign of suspicion)
TH4	Thermogram with one malignancy criterion
TH5	Thermogram with several malignancy criteria

Our usual examination technique is as follows: the patient is unclothed to the waist, raised arms supported by straps avoiding a usuless tiredness. Thorax and axilla and sub-clavicular sulcus are atomized with a cooling liquid which is evaporated in front of a fan for 10 minutes. As usual, one frontal and two left and right oblique views are taken in order to have the outer quadrants and the connection of the mammary skin to the thorax and the axillary sulcus well drawn.

In a first analytical time, 4 parameters are considered: the vascularization, the gradient of the local thermal rise (hot spot), the one of the whole breast temperature (full hyperthermia) and, lastly, the regularity or not of the thermal outlines of the breast (edge sign).

According to the importance of the registered abnormalities at these parameters level, we have described 4 *suspicion signs and 4 malignancy criteria* which are exhibited in Table I.

1) The four suspicion signs are:

the vascular asymmetry, that is either an asymmetry of the vascular distribution at

Fig. 1. Isolated hypervascularization of an anarchic type (disturbed vessels, thick caliber). Ca-*tegory 7‘19s* (adenocarcinoma).

Fig. 2. Stiffness of the inferior thermal outline of the left breast. Extended *edge sign. Category TH4* (carcinoma of a scirrhus type).

the breast level (the vascularization was clearly more marked on one side) or a caliber vessel asymmetry. The caliber was thick on one side (Fig. 5).

the hot spot (of less than 5 cm² area), the thermal gradient of which compared to the symmetric area being equal to 2.5°C. We have selected 2,5°C as a *significant themal threshold* for it is exactly the average and the median of our 1,000 first mammary carcinomas thermal rises (gradients measured and compared to the surrounding healthy tissues or AT).

the whole breast hyperthermia, that is a diffuse hyperthcrmia covering the whole breast by +2°C.

the localized edge sign, not extending the quadrant.[5]

2) The four malignancy signs are:

an anarchic hypervascularization, that is disturbed, disorganized and not systematized (Fig. 1).

- a hot spot by 3°C or above (Fig. 6).

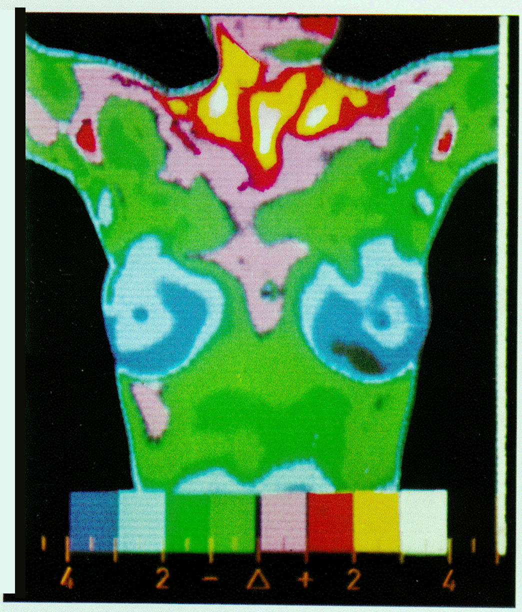


Fig. 3. Thermogram of a normal type. Cold. isothermal breasts, without any vascularization. Ca-*tegory TH1*.

Fig. 4. Thermogram of a benign type. Bilateral and symmetrical hypervascularization without abnormal thermal emission. Category ***TH2*** (bilatc-ral mastosis in this instance).

- a whole hyperthermia of a breast by +2°C.

- an extended edge sign covering more than one quadrant (Fig. 2). There is evidence that the edge sign is an indirect thermographic sign but it is often better seen on the thermogram than at physical examination.

In a second synthetical time, we classify the thermovisual mammary images into five categories (Table II and figures from 3 to 8).

Our current experience is supported by 25.000 mammary thermograms, 3097 of which being carried out for tumors which have been *confirmed rnicroscopically,* later on. Amongst those, we count 1878 *cancers,* all having had previously a physical examination, an X-ray film, besides thermography and microscopic examination. It is the result of this *quadruple confrontation* which forms the subject of the present report.

We specify that a systematic screening is not involved here but a continuous series of 1878 women bearing a breast cancer. The

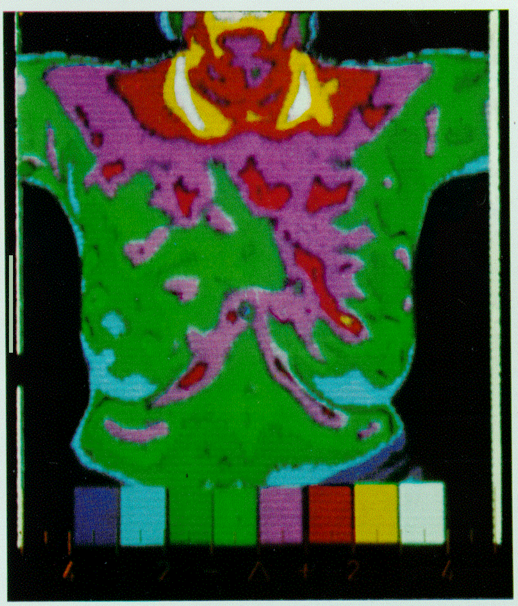


Fig. 5. *Suspicious* thermogram. Unilateral, asymmetric hypervascularization. *Category TH3* (adenocarcinoma in this case).

Fig. 6. Thermogram with one malignancy sign only: a hot spot of 4 °C on the left. *Category TH4* (confirmed adenocarcinoma).

Fig. 7. Thermogram with several criteria of malignancy; hot area of 5 °C with an anarchic vascularization. *Category TH5* (adenocarcinoma).

Fig. 8. Fast growing cancer of the right breast, in evolutivc phase, hyperthermia ot 8 °C, exceeding the breast limits; *Category TH5* PEV.

consultation was justified due to a mammary functional and/or physical sign.

The study of these 1878 cancers distribution, according to our classification, shows that there were 9% of all the cases which appeared under falsely normal or falsely benign thermovisual pattern (THl or TH2). These are the telethermography *false negatives.*

Opposite to it, there were one or several thermal malignancy criteria (TH4 or TH5) in 71% of the studied cancers; these are the actual positives (Table I I I).

Hetween these two clearly divided groups, we find in 20% of cases thermograms of a *TH3 category* being only suspicious or doubtful. We have searched for the real *meaning* of this image type: out of 644 palpable tumors, showing a thermal suspicion sign, a microscopical verification has evidenced 376 existing cancers, i.e. 58% of cases. In these terms, we can say that more than once out of *two*, a *palpable* tumor showing a TH3 image is a cancer; therefore, we cannot neglect this category of thermograms.

Table **111. Distribution of 1878 mammary carcinomas according to their tbermovisual category.**

	N. cases	%	
THl	15	<1%	= 9% of false-negatives
TH2	151	8%	
TH3	376	*20%*	=20% of suspicious or doubtful
TH4	*626*	33%	=71% of real positives
TH5	710	38	
	1878	100%	

This distribution of cancers in 5 thermovisual categories varies considerably, depending on the *clinical extension* of the examined cancer.

Indeed, if we consider all the cases, the abnormal thermographic rate (TH3 + TH4 + TH5) is 91% (Table IV). If we only look at the advanced cases of the International Union Against Cancer, T3 and T4 categories, this rate reaches 97 to 99%. If we apply to cases a little advanced of T2 categories (between 2 and 5 cm in diameter), this same rate is 90% and, lastly, for the Tl category (up to 2 cm in diameter), it falls to 71% only. This means that we can have up to *29% of false negatives of telethermography in small size cancers* and this notion has to be kept in mind for the mass screening tests.

After the false-negatives, we have systematically searched for the falsely positive results of telethermography owing to the microscopical verification of the quasi-totality (96%) of cases showing one or several thermal malignancy criteria.

Out of 1473 controlled images TH4 and TH5, the *false-positive total rate is 9%* (Table V); it reaches 15% when there was only one malignancy criterion (category TH4) and it falls to 4% when there were several malignancy criteria (category TH5).

To get rid of these false-positive and false-negatives of telethermography, it is absolutely necessary to use this method, solely in the *combined diagnosis outline,* besides the clinical examination (essential) and the X-ray (with molybdenum anode).

Table IV. **Distribution of tbermovisual categories in terms of the examined cancers clinical extension.**

	I. U. A. C.				
	T1	T2	T3	T4	
TH1 + TH2	45	103	16	2	166
TH3+TH4+TH5	113	904	504	191	1712
	158	1007	520	163	1878
TV > 0	71%	90%	97%	99%	91%

Which is the place of telethermography in the balance of a mammary disease?

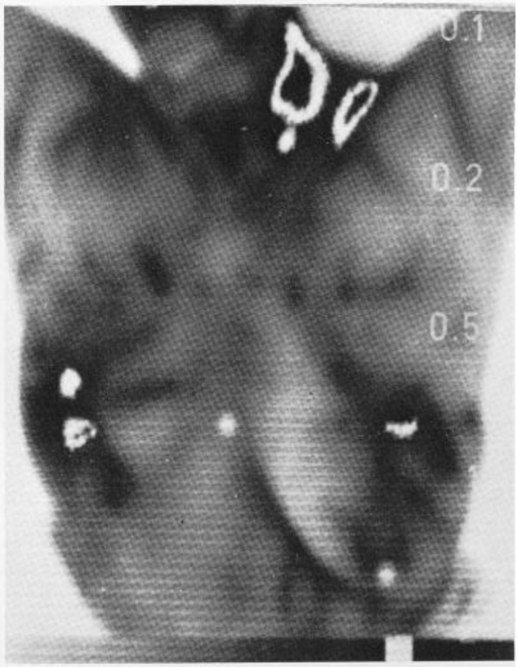
For us, telethermography takes place immediately after the interrogatory examination: it is followed in all cases by an X-ray film (localized on the eventual thermal abnormalities, reference marked on the skin).

A complete, methodical, physical examination is then performed after having enquired into the thermographic and radiographic images.

Finally, when a palpable tumor is found, we make a needle aspiration biopsy and if it involves a cyst, a pneumo-cystography to

Table V. **False-positive rate of telethermography.**

	Positive fhermography	*False-positive*	*Rate*
	1473	137	9%
One malignancy criterion TH4	733	107	15%
Several criteria TH5	740	30	4%



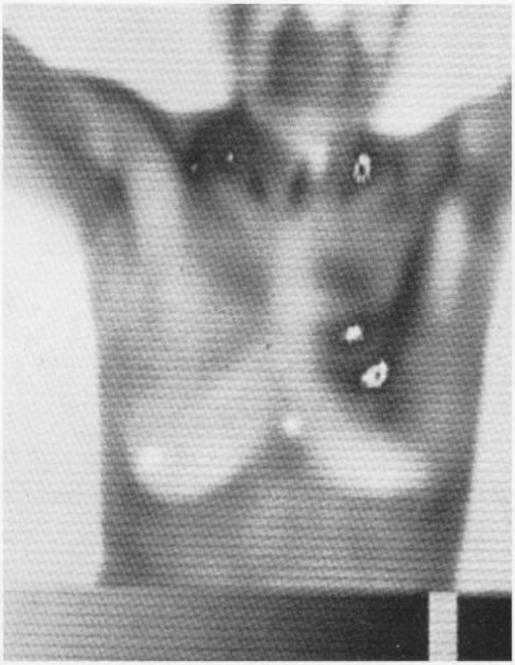


Fig. 9. Bifocal mammary carcinoma with 2 well apart hot spots at the level of 2 palpable nodes (confirmed microscopically).

Fig. 10. ***Synchronous bilateral mammary carcinoma.*** Clinically obvious on the right, subclinical on the left. (Positive microscopic verification on both sides).

verify the regularity of the internal walls.

The advantage of this *quadruple diagnosis* (« Tétrade ») is triple:

1. All these non-bloody examinations may be performed in 2-3 hours in a specialized medical department (Senology Unit) with no need to resort to surgery in every case.
2. The reliability of this quadruple examination reaches 99%, each method being able to avoid the plus or minus errors of the others.
3. This systematic quadruple confrontation has afforded us to evidence owing to *infrareds* ***176*** *sub-clinical or occult cancers.*

Indeed, out of our 1878 mammary carcinomas, we count:

- 2 1 non palpable microcarcinomas
- 75 clinically benign cancers
- 80 radiologically benign cancers, that is 9% of our cancers (176/1878).

All these cancers showed thermal abnormalities sufficiently evocative to formally indicate an excisional biopsy.

- Our *21 non palpable carcinomas* with 3-5 mm in diameter have been evidenced owing to a wide wedge resection centered on the thermographic data and then by an X-ray film of the operative part.
- Our 155 *occult cancer,* with an average diameter of 10 mm, have been localized, due to an apposite abnormal thermal emission; once out of two, they were localized amongst other really benign nodes, palpable or visible on the X-ray film.

In all these small size mammary carcinomas, thermography may bring an original alert and encourage their accurate radio-surgical tracking for their histological identification.

Besides the detection of breast cancers themselves, telethermography may bring information of importance regarding the detection of *their real extension and evolutive potential.*

As a matter of fact, in our statistics, the infra-reds have shown:

- a plurifocality of lesions in the same breast, in 42% of cases (Fig. 9); by plurifocality, we mean: no several separate spots or hot areas well individualized inside a same breast.
- a synchronous bilateral cancer at the first examination in 4% of cases (Fig. 10).
- a metastatic lymph node in 30% of axillas;
- finally, at distance metastases, at the first balance, in 5% of cases.

We could evidence these last ones owing to telethermography of the whole body (at 6 meters distance or at 3 meters with a normal 15" lens by taking successively the upper half, then the lower half of the subject). This « total body thermography » has even shown us quite a few numbers of sub-clinical, cutaneous, sub-cutaneous or bone metastases; it can also evidence secondary, pleural, mediastinal, choroidian or hepatic localizations.

But it is mainly in the *fast growing cancer detection* that telethermography may be the most helpful. We know that a lot of mammary carcinomas (10 to 20% according to the statistics) may show growths or « evolutive phases » and that, in these cases, any at once surgical action may come along with early local recurrences and be exceeded by a fast generalization (Fig. 8).

We may suspect the existence of such evolutive growths, during the interrogatory (when a tumor increases in volume rapidly) or during the physical examination (breast oedema with pink skin or carcinomatous mastitis in the extreme cases).

But telethermography allows to make them appear by showing a very extended hot area (covering the whole breast or even exceeding it, while the palpable tumor is relatively limited) with a very high thermal rise (from 4 to 14°C).

Differences in temperature which may appear unbelievable have been verified with absolute temperature measurements. However, it has to be specified that the opposite normal breast was often very cold explaining partly that such high gradients could be obtained; that is what we call the « too hot » cancers (Fig. 8). We have met 11% of them in our statistics and 17% of these fast growing cancers had no clinical translation.*

The identification of these cancers in evolutive phase, before any treatment, is essential for the choice of therapeutics and prognosis. Effectively, since Llyod-William's studies,' we know that there is a *thermal prognosis* of *breast cancer,* the five-year survival rate being inversely proportional to the thermal rise importance.

Very lately, Jones et Al.6 has shown that the 3 years-survival of breast cancers (Stages II and III) with thermal abnormalities was clearly inferior to those of cancers at the same stage with normal thermogram (61% against 84%).

This difference increases considerably if we compare as we have done (Table VI),

Table VI. Thermal prognosis.

Cancers	*N. cases*	*Failure at 3 years*	*Alive*
Hyperhot: 4°C and over (fast growing cancers)	25	19=76%	24%
Cold cancers: 0 to 2°C (false negatives)	20	4=20%	SO%

the cold cancers and the hyperhot cancers (Stages II and III gathered).

- the « cold » cancers are the false-negatives of telethermography, their thermal rise is no more than 2°C and their prognosis is good: 80% of 3 years - survival.
- the « *too hot* » cancers (4°C and above) are the fast growing forms and their prognosis is very poor: 24% of 3 years survival.

In the *positive diagnosis* of breast cancers, thermography gives between 9 and 29% of false-negatives and in another connection 9% of false-positives. We must be fully aware of this method limits which may misknow a palpable cancer or, on the opposite, see a non palpable cancer...

Thermography should not be used alone, it must enter a combined diagnosis outline where the mutual diagnosis safety is ensured, each method having different error causes.

At this price, the errors, before any histological control, are reduced to less than 1% and telethermography may give all its measure beyond the positive diagnosis; indeed, on our 1878 confirmed cancers:

- 9% could not be identified, neither by physical examination, nor by X-ray: they have been detected or localized owing to infra-reds only.
- 11% had an excessive thermogenesis which constitutes an alert often original in fast growing cancers and a prognostic touch independent to the volume (poor prognosis).
- 9% had no cutaneous thermal manifestations (potential good prognosis).
- 5 % , finally, showed on at distant metastasis on the first examination, evidenced by the corporeal thermography.

In total, Dynamic Telethermography provides original data in 3 cases *out* of *10* (34%).

Functional test, thermography will still ask the physicians more work, carefulness and imagination. Through its cutaneous thermographic manifestations, the cancer betrays a reflexion of its thermo-kinetic behaviour.

REFERENCES

1. **Amalric** R., **Spitalier** J. M., **Levraud** J., **AlTschuler** C.: Les images thermovisuelles des cancers du sein et leur classification. ***Corse Mediterranée Médicale,*** 216, 13-22, 1972.
2. **Amalric** R., **Pollet** J. F., **Robert** F., **Altschuler C.**, **Giraud** D., **Spitalier** J. M.: Cameras rapides à infra-rouges devant 1000 cancers du sein. ***Méditerranée Médicale, 40,*** 99-111, 1974.
3. **Amalric** R., **Giraud** D., **Altschuler C.**, **Spitalier** J. M.: Thermography in diagnosis of breast diseases, ***Thermography,*** Bibliotheca Radiologica n. 6, S. Karger ed. Basel, 65-76, 1975.
4. **Giraud** D., **Altschuler C.**, **Amalric** R.: Thermogrammes mammaires normaux et aspects vasculaires. ***Méditerranée Médicale,*** 2, 101-110, *1973.*
5. **IsaRD** H. J.: Thermographic « edge sign » in breast carcinomas. Cancer, 30, 957-963, 1972.
6. **Jones** CH., **Greening** W. P., **Davey** J. B., Mc **Kinna** T.A.. **Greeves** V. I.: Thermography of the female breast: a five-year study in relation to the detection and prognosis of cancer. ***Brit. J. Radiol., 48, 532-538, 1975.***
7. **Llyod Williams** K.: Thermography in the prognosis of breast cancer. ***Medical Thermography,*** Bibliotheca Radiologica n. 5. S. Karger ed., Basel, 62-67, 1969.
8. **Spitalier J. M., Clerc S., Giraud** D., **Ayme Y., Pietra J. C., Amalric** R., **Incrand** J.: La notion thermovisuelle de croissance rapide dans les cancers du sein. ***Méditerranée Médicale, 76,*** 15-26, 1975.

The role of thermography in ORL neck lesions*

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SUMMARY. **The normal thermographic pattern of the neck is described in the lateral and frontal views. The various areas are characterized by hot, warm, and cool values.**
A characteristic thermogram of the neck is defined. Different lesions can modify the normal thermographic pattern by increasing or decreasing temperatures. The parotid, supra-hyoid, sub-hyoid, and laterocervical regions are described with their pathologic changes: special attention is given to the diseases of the salivary glands. Finally, the role of thermography in the diagnosis of diseases of the neck is discussed.

Key words: normal neck thermogram; neck lesions; salivary glands diseases.

The detection of skin areas temperature by means of a thermograph permitted the advance of a new technique for investigating different body lesions [1].

Skin temperature is closely related to the anatomical (vascular) and functional (metabolic) situation of the region: this relationship is the background of the different thermal patterns which are represented in the thermograms.

Several lesions modify the thermal patterns of the involved areas and, in some instances, those of the surrounding ones; modifications correspond to an increase (hyperthermia) or to a decrease (hypothermia) of the skin temperature. A quantitative evaluation is necessary for distinguishing two levels of a same temperature modification (e.g. hyperthermal changes). The thermal gradient (Δt) between two body areas permits the evaluation of the temperature differences existing between symmetric or adjacent regions. The thermal gradient is particularly important when a lesion modifies the normal thermal pattern of an area, the At value being related to some typical lesions, such as inflammatory diseases, benign versus malignant tumours, congenital abnormalities, etc.

The ORL diseases of the neck represent a kind of lesions suitable for thermographic investigation as they are localized in a region easily explored by means of thermography, they give a characteristic thermogram, and they involve deep structures (vessels, glands, etc.) which give superficial thermal manifestations.

THERMOGRAPHIC ANATOMY

The normal neck thermogram has not yet been established [3]. Therefore, the possibility of comparing pathological thermograms to a standard one is not yet possible. We tried to define a normal thermogram which would take into account individual variations and which could be suitable for these comparaisons.

The normal temperature distribution is represented in figure 1 where the main thermal areas of the neck are shown, each of them characterized by temperature values defined according to three different levels (hot, warm, and cool).

The *normal thermogram* has been based on two standard views:

* Invited paper presented at the 6th International Congress of Radiology in ORL (Copenhagen, 31st May - 3rd June 1976).

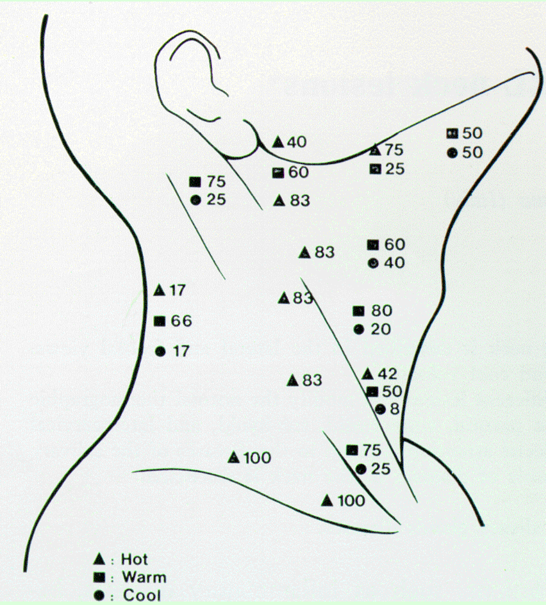


Fig. 1. Normal thermal distribution in the diffc-rent areas of the neck. Numbers indicate the percentage of occurence of cool. warm, and hot values.

1. lateral oblique with slightly extended head;
2. frontal, with hyperextended head.

1. In the lateral view the following areas are identified (Fig. 2):

a) Parotid area: the region has a thermo graphic pattern which is constantly warm or hot became of the superficial situa-tion of the parotid gland and of the va-scular structure5 (external jugular vein and external carotid artery) which pass through the gland.

A part of the parotid gland is covered by the masseter muscle and therefore it appears cool; on the other hand this part of the gland does not really belong to the neck but to the facial area.

b) **Supra and sub-hyoid areas:** these two region5 arc represented on a small sur-face when investigated on the lateral view. Their thermal characteristics arc described in the frontal view.

c) Sternocleidomastoid area: the corres-pondence of this region to the sterno-cleidomastoid muscle explains the cx-tension of warm values. The region is crossed by an hot line directed down-wards and posteriorly and which cor-responds to the external jugular vein.

d) Supra-clavicular area: it reprcsents the

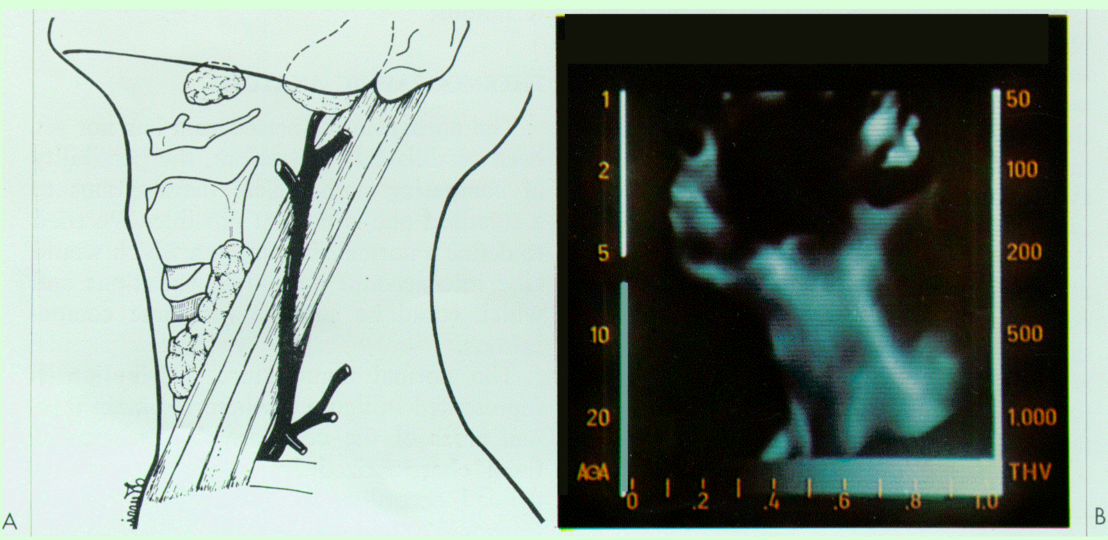


Fig. 2. Lateral vicw. A) Anatomic illustration of the rcgions cxplorcd by thcrmography. B) Normal thermogram.

posterior part of the neck, corresponding to scalenes and trapezium muscles. It has almost always warm and uniform values. In its inferior part there is an hot spot which corresponds to vascular structures irradiating from this zone.

e) Vascular lines: they have very hot values and reach the supraclavicular hyperthermal region coming down from the region of the mandibular angle and surrounding the posterior aspect of the sternocleidomastoid muscle.

2. The frontal view permits the identification of the following regions (Fig. 3):

a) **Supra-hyoid area:** the normal thermographic pattern of this region is constantly characterized by warm or cool values. Nevertheless, on both sides of the midline just below the jaw in the *sub-maxillary region*, an area presenting hot or warm values is constantly recognizable. It could correspond, in its posterior aspect, to the submaxillary gland and, in its anterior aspect, to a branch of the facial artery crossing the platisma and reaching the subcutaneous tissues. Anterior jugular veins which lie on both sides of the midline in the superficial planes do not give a constant thermographically valuable pattern.

b) **Sub-hyoid area:** this region is characterized by warm or cool **values** whose pattern is not homogeneous, the thermal values progressively increasing from above downwards. The superior third of the region is normally cool (larynx and thyroid cartilage), while the inferior two/thirds arc usually warm (thyroid gland).

c) Sternocleidomastoid area: this region is well examined - in the frontal view - only in the inferior two thirds, its upper part being situated in the lateral aspect of the neck. The vascular line is easily recognizable in this view, too.

d) **Supra-clavicular area:** a very limited part of this region is recognizable in the frontal view and it has always a hyperthermal pattern. This is due to the inferior tract of the external jugular vein and to several small venous branches which are superficial at this point of the area.

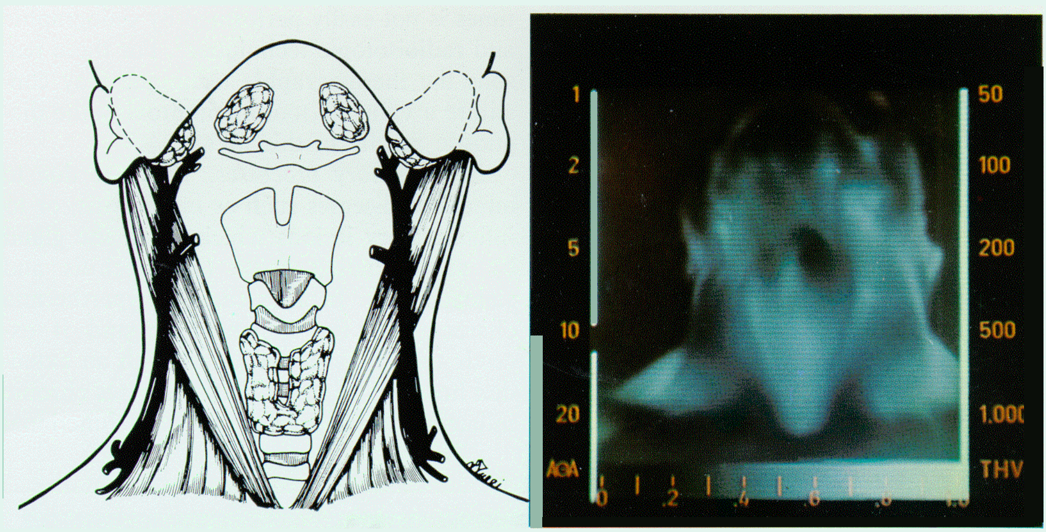


Fig. 3. Frontal view. A) Anatomic illustration of the regions explored by thermography. B) Normal thermogram.

e) Parotid area: this region is seldom identified in the frontal view. It appears on upper external zones of the neck when parotid glands are enlarged.

The description of the neck thermograms reveals that the differences which normally exist among the neck temperatures are mainly due to anatomical reasons, such as the site and the level of vascular structures. Nevertheless, some differences are due to the functional activity of very particular regions, such as the parotid and thyroid glands.

THERMOGRAPHIC PATTERNS IN ORL NECK LESIONS

The lesions of the neck structures may present different thermographic patterns, which are similar to other regions, that is: lesions with increased temperature (hyperthermia); lesions with decreased temperature (hypothermia); lesions with no variations of the temperature (normothermia).

The temperature variations may be isolated to a single region of the neck or to be widespread to several regions which are contemporarly attained.

The description takes into account the thermal modifications which can be encountered in the different neck regions. For an easier description sternocleidomastoid and supra-clavicular areas will be named latero-cervical region.

Parotid region. It is attained by many lesions with some very typical thermographic patterns. The diagnostic of this region sometimes is not easily performed by sialographic and radioisotopic techniques [2]. For these reasons the thermographic technique may constitute a valuable tool for improving the diagnostic results in this area.

Inflammatory processes. They are due to infectious diseases such as in parotitis, or to inflammatory lesions which reach the gland by an ascending route (sialodochitis and sialoadenitis). In both cases a hyperthermia characterizes the inflammation and it exceeds the limits of the gland with an extended hot spot (Fig. 4a). In some cases chronic inflammatory lesions result in a functional

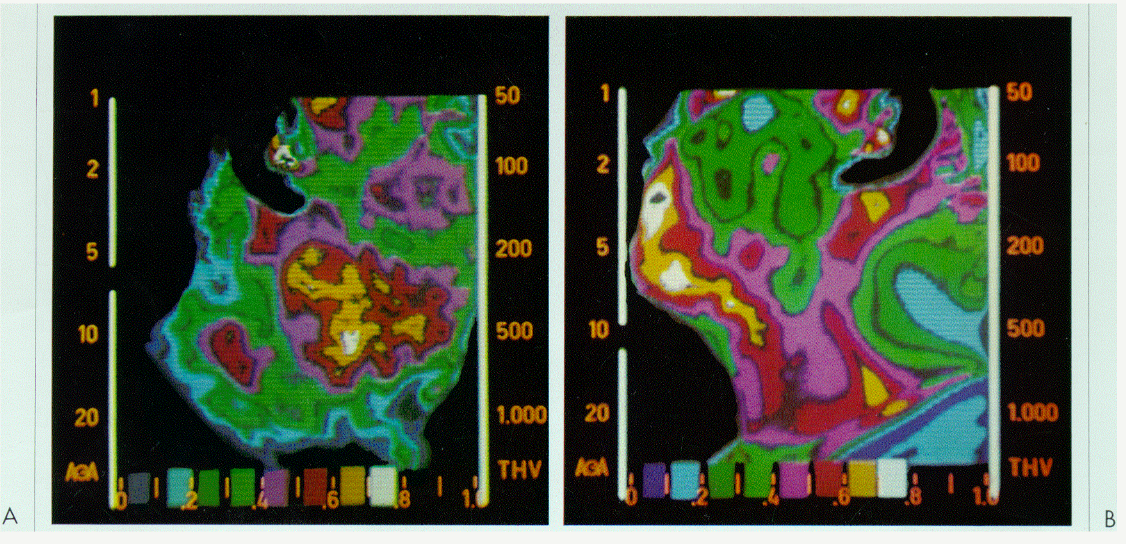
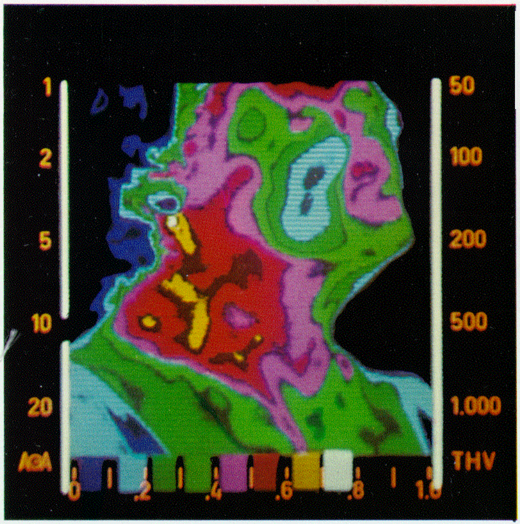


Fig. 4. A) Acute parotitis: lateral thermogram showing a hyperthermal area extended to the right pre-auricolar, retro-mandibular and sub-mandibular regions. B) Chronic parotitis: lateral thermogram showing the unusual hypothermia extended to the parotid region and to the mandibular angle.



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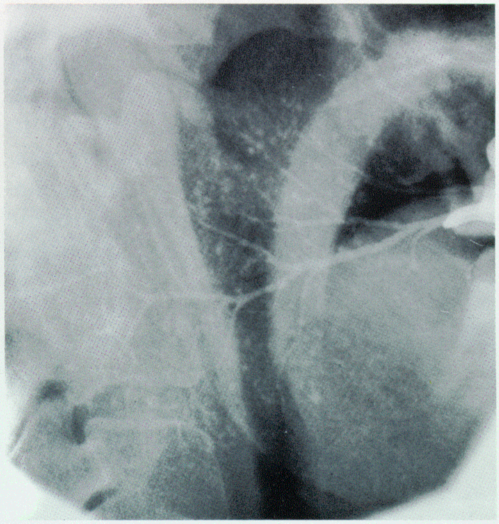

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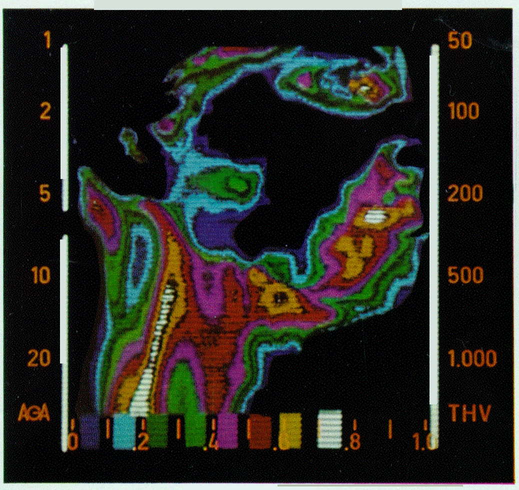
Fig. 5. Sclerodermia. A) Lateral thermogram showing a diffuse hyperthermia extended to the parotid and to the sub-maxillary regions. B) Sialographic pattern denoting a typical inflammatory phase with several, small, rounded opacities (sialectasies).



A

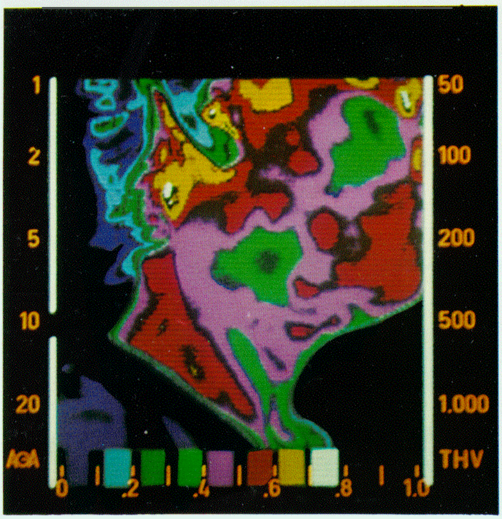
B

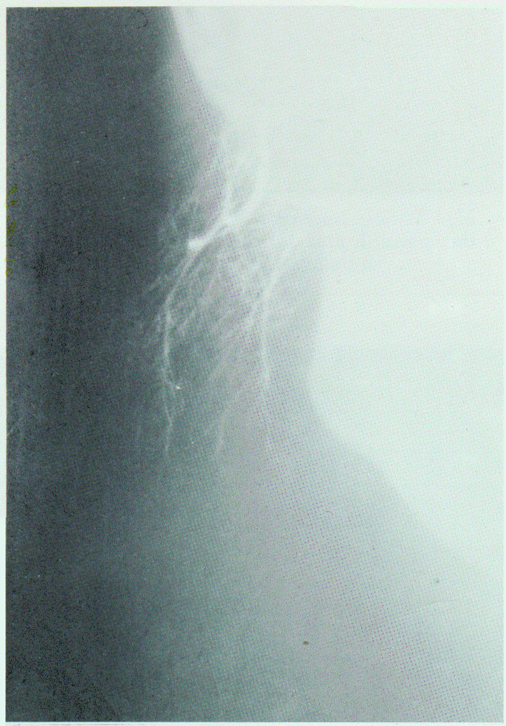
Fig. 6. Sjögren disease. A) I.ateral thermogr·am showing the extension of the hypothermia to the parotid and to the sub-maxillary regions. B) Sialographic appearance of the right parotid gland in the samc subject: ducts are lacking and short..

death of the parotid gland which appears on the thermogram as a hypothermal area, in spite of existing inflammatory modifications of the parotid ducts (Fig. 4b).

Collagenous *lesions*. The participation of salivary glands to several collagenous diseases has been widely investigated and sialographic manifestations are extensively described in the literature. Thermographic manifestations of these diseases in the parotid area arc often recognized. The temperature modification may be detected as an increase of thermal values when the gland is still in the early or intermediate inflammatory phases (fig. 5). The late phases of many collagenous diseases conduct towards an atrophic stade of the salivary glands and this situa-

masses of the region. Sometimes sialography shows the parotid gland integrity, but in some instances the intraglandular ducts are displaced as in mixed tumours and sialography is not consistent. Benign masses are characterized by warm or normal thermographic values as in the salivary cysts or by cool values as in the lypomatous disease of the gland.





B

Fig. 7. Dysontogenetic cyst. A) On the lateral thermogram, a large hypothermal area is localized at the mandibular angle, just below the inferior aspect of the parotid area. B) Sialographic appearance of the displaced parotid gland which is not involved by the cyst.

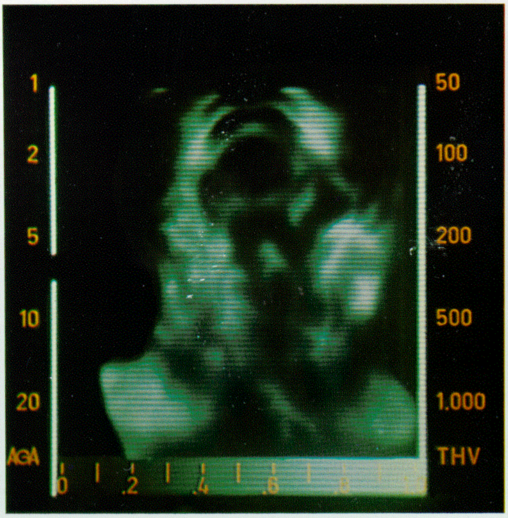
tion is thermographically detected as an extended cool pattern of the whole parotid area (Fig. 6).

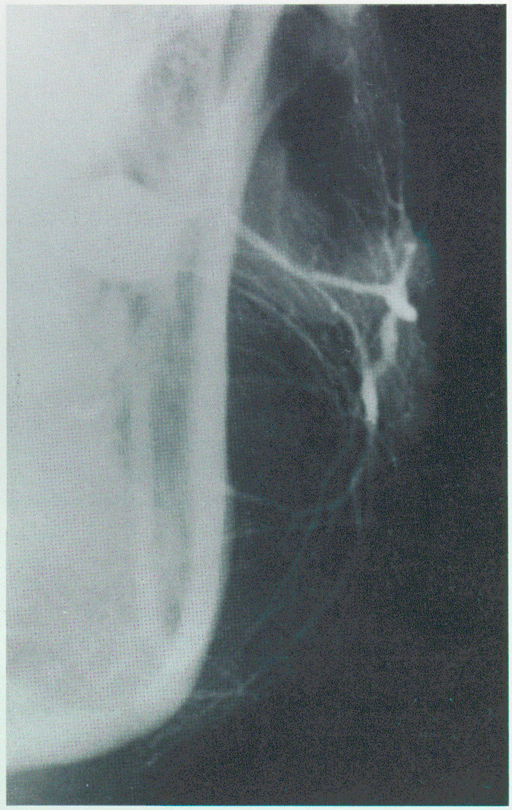
For these reasons it should be possible to check by thermography the progression of the collagenous involvement in salivary glands related to different temperature values encountered in the corresponding regions (parotid and submaxillary areas).

Benign masses. They are difficult to be clinically differentiated from the mixed tumours which are among the most common

A case of an enormous dysontogenetic cyst with necrotic phenomena, situated at the mandibular angle and displacing outwards the inferior aspect of the parotid gland, appeared very cool, probably due to the avascular mass with necrosis (Fig. 7).

Mixed or malignant masses. The description of mixed and malignant tumours together derives from the fact that they are all characterized by hyperthermal values on the thermogram. Nevertheless the hyperthermal modification due to a mixed tumour (Fig. 8)





B

Fig. 8. Mixed tumour of the left parotid gland. A) The frontal thermogram shows a hyperthermal area at the inferior pole of the parotid region. B) Sialographic examination: the ducts are regularly displaced by the tumour.

is generally less noticeable and more limited than that of other malignancies, where the spread of the hot temperature outside the parotid region signifies the extensive involvement of the surrounding structures (Fig. 9). This latter thermographical pattern may be also encountered when primary tumours situated outside the parotid region spread into it during their growth.

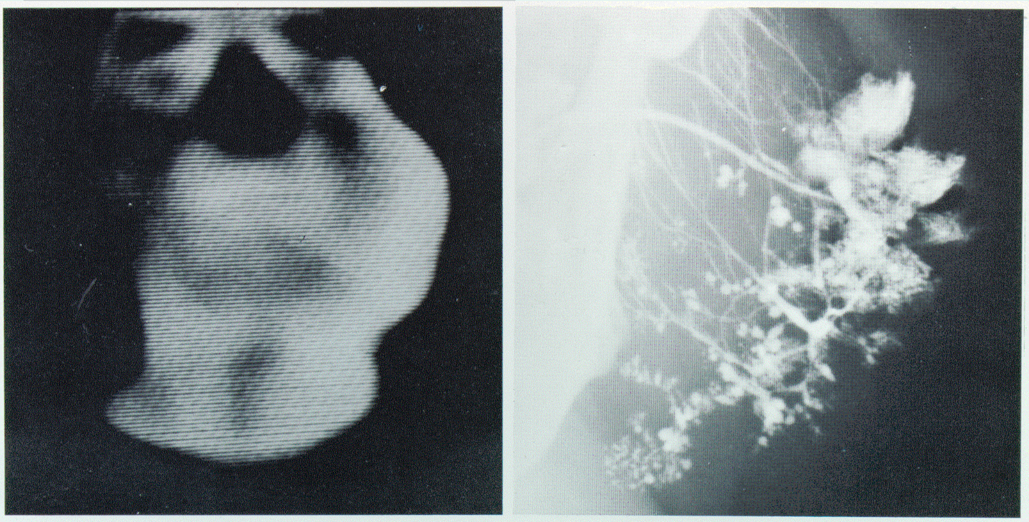
Supra-hyoid region. The thermographic importance of this region is due to the submaxillary glands contained, the lesions of which may give characteristic temperature modifications. Moreover, the superficial projection of these glands being very limited, regional abnormalities can be easily detected.

Lithiasis. The lesion is the most common disease affecting the sub-maxillary glands. In general it does not give important modifications on the thermogram: temperature values may be in the range or below the normal ones (Fig. 10a).

Consistent temperature modifications are encountered when *inflammatory lesions* are superimposed on a lithiasis. In these cases the thermographic pattern is analogous to the modification of sialoadenitis where the hot values characterize the disease (Fig. 10b).

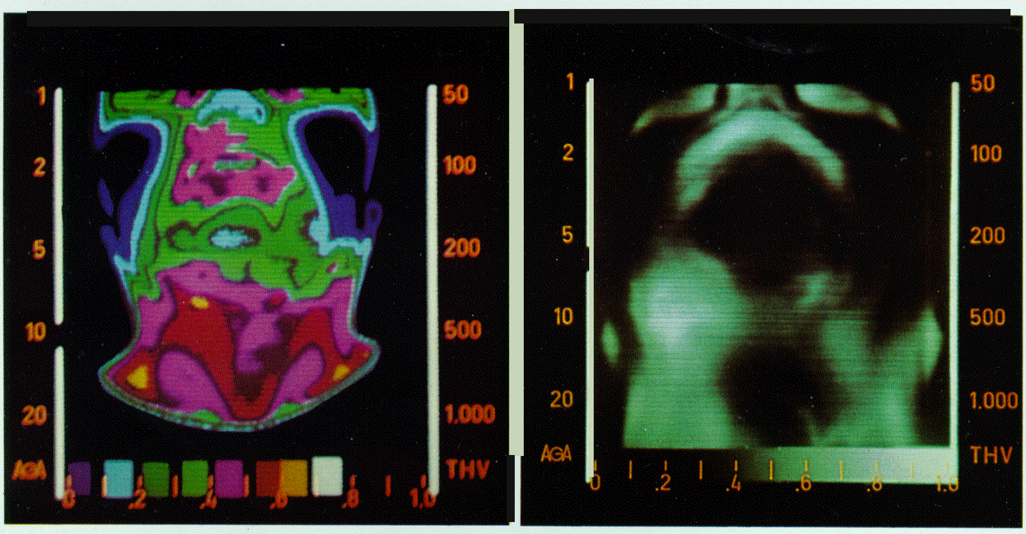
In some instances the inflammatory lesion does not originate from the submaxillary gland. The whole supra-hyoid region may be invaded by a very hot area with extension to the adjacent sub-hyoid region when phlegmon infections are localized to the mouth floor.

Sub-hyoid region. The importance of this region in thermography is related to thyroid



A B

Fig. 9. Reticulum cell sarcoma of the left parotid gland. A) The frontal thermogram shows an extended hyperthermal area corresponding to the mass involving the parotid structures. B) Sialographic examination: enlarged parotid gland, with distorted ducts and irregular contrast medium opacities.



A B

Fig. 10. A) Left sub-maxillary lithiasis: frontal thermogram showing cool temperatute values in the sub-maxillary arca. B) Right sub-maxillary sialoadcnitis: the frontal thermogram reveals a marked hyperthermia in the sub-maxillary area.

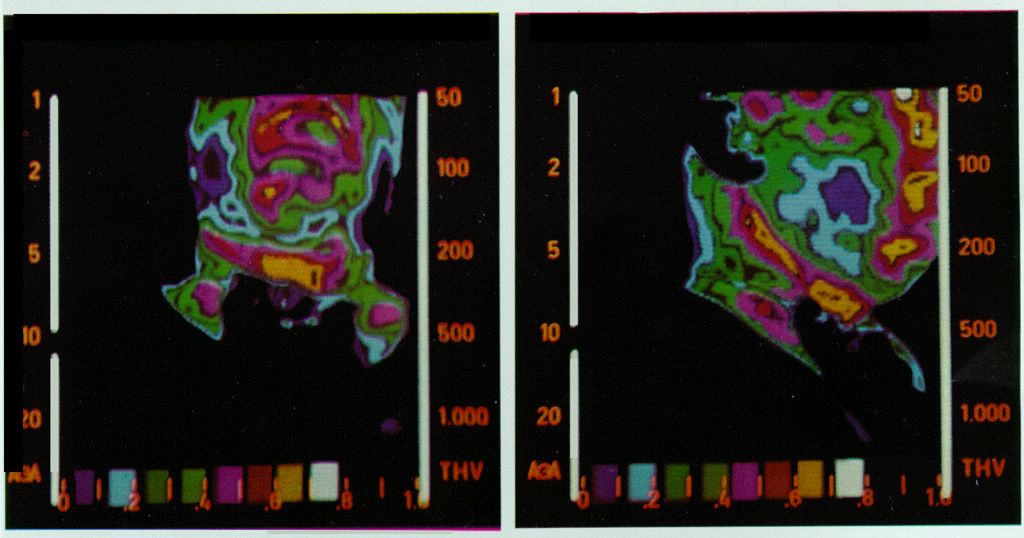
diseases. Nevertheless some other abnormalities may present a thermographic modification of this region.

Larynx and pharynx tumours. The hyperthermal modification which laryngeal and pharyngeal malignancies may present, is not easily conducible to a schematic rcpresentation. When hyperthermia is evident it has generally a very extended pattern and it does not correspond closely to the anatomic lesions. This may be due to the relatively deep structures involved in these tumours (Fig. I la). Nevertheless the identification of the most affected side is possible and this fact permits one to study adequately the treatment planning: the importance of this study is evidently due to the frequent coexistence of metastatic nodes. The detection and localization of the metastatic secondary nodes is very important from the laryngological point of view. Laryngeal cancer may be accompanied by metastatic nodes in the neck region. On the other hand, recurrences of operated laryngeal cancers are almost exclusively localized to these regions. Figure 11 b shows the dishomogeneous. hyperthermal pattern of a patient operated by laryngectomy, having an extended recurrence affecting the laterocervical lymphatic nodes. In many other cases it was possible to detect the invasion of lymphatic nodes by carcinomatous metastasis originating from the parotid, the larynx or the pharynx.

Laterocervical region. The region comprises the two anatomical areas formarly described as stcrnocleidotnastoid and supraclavicular areas. The opportunity of describing them together as a single region derives from the distribution of pathological lesions which affect indeffcrcntely one or both areas and by the fact that thermal modifications **may** be widespread in the whole regional surface.

Vascular abnormalities. When increased vascularity occurs, the best situation for thermographic modifications is realized. Vascular changes in the artero-venous fistulas of the neck are easily detectcd by thermography, appearing as an hot spot in the area of the more superficial vascular involvement. Sometimes the vascular involvement is clinically evident as a well limited, palpable, pulsating mass in the laterocervical region, with an extended hyperthermia on the thermogram. In the case of figure 12, the operation demonstrated the presence of chemodectoma originating from the carotid bifurcation and greatly extended upwards.

Vascular modifications constantly **occur** when radiation theraphy is performed. The thermographic detection of these changes in the laterocervical area is a good method for evaluating the **tissue** response to the absor-



A B

Fig. 1 1. A) Laryngeal cancer. Thermogram in frontal view, showing a hyperthermal area
situated in the midline of the sub-hyoid rep B) Operated laryngeal cancer: lateral ther-
mograms showing an extended hypertherma mal involving both the laterocervical lympha-
tic chains, and the supra-sub-hyoid regions.

bed doses. Some Authors' proposc the thertnographic evaluation of the temperature changes in the latcrocervical area following preoperative radiotherapy, as a tool for proposing the most opportune time in head and neck cancer surgery.

CONCLUSIONS

The role of thermography in neck lesions is not yet sufficiently defined. Almost all lesions affecting neck structures give a thermographic evidence of their cxistcnce.

The thermographic modifications are mainly hyperthermal. but hypothermal patterns are not unusual. Moreover thermal characteristics are often identical in many diseases. Hyperthermia, for example, is evident in malignancies and in mixed tumours of the parotid gland.

The At evaluation in many instance5 permits the differentiation of primary tumour hypcrthermia (At = 3° C) from the mixed tumour changes (At = 1.5°-2° C).

In addition, thermography is a usefull method for evaluating the evolution of many diseases. The method permits one to check the vascular or functional modification5 of some regions, either in chronic conditions as in collagenous and tumoral lesions, or in acute manifestations as in inflammatory diseases.

The validity of thermography in ORL neck lesions seems to be consistent with these points:

- Salivary glands lesion5 are easily recognizablc because of the superficial position of these structure. Moreover the temperature modifications have almost always a good concordance with the lesion nature.
- Pharynx and larynx lesions arc scarcely detectable because the involvement of these structure5 must bc greatly extended before the temperature modification reaches the superficial planes.
- Lymphatic node lesions do not present characteristic features permitting an accurate diagnosis of their localization in the neck, except for the hyperthermal values which characterize the carcinomatous origin.
- Vascular abnormalities have a good chance to be detected because of the high increase of temperature they cause.

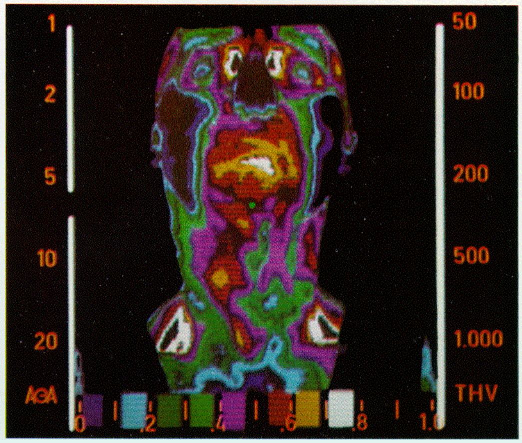


Fig. 12. Chemodectoma of the right carotid bifurcation. Frontal thermogram showing an extended hyperthermal area situated outside the carotid axis. just medially to the sternocleidomastoid muscle.

The role of thermography as a bloodless method for detecting or checking many neck lesions should be further clarified. It must be stressed that thermography alone is not sufficient for an exact definition of the nature of the Icsions.

Thermography should be linked to other diagnostic examinations such as sialography, radioisotopic studies, tomography, etc. In this role it has certainly good chances for improving its value.

REFERENCES

1. AARTS N. J. M., GAUTHERIE M., RING E. F. J.: Thermography. S. Kargcr ed., Base1 1975.
2. BRANDS T.: *Diagnose und Klinik der Erkrankungen der grossen Kopfspeicheldrüsen*. Urban & Schwarzenberg, München, 1972.
3. CALVET J., TOROSSIAN F., NAJA A., LECINE A., LABRY J.: Apport de la téléthermographie dynamiquc en cancérologie cervico-faciale. *Méditerranée Médicale, 2, 38-40, 1973.*
4. WHITE R.L., EL.-MAHDI A. M., RAMIREZ H. L., TEATES C. D., CONSTABLE W. C.: Thermographic changes following preoperative radiotherapy in head and neck cancer. *Radiology*. 117, 469-471, 1975.

THERMOGRAPHY IN THE WORLD

This survey reports all information reaching the Editor about meetings with main or partial subject on thermographic applications. It is also available to all thermographic Societies for printing meetings' abstracts.

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■ **WASHINGTON (U.S.A.).** On June 26th and 27th 1975, a meeting of Thermographers was held in Washington to clarify some of the technical problems and particularly interpretative criteria of breast thermography. The meeting was sponsored by Dr. William Pomerance of NCI. « *Thermographic Quarterly* », a new publication of the American Thermographic Society, reports the conclusions of the meeting about more objective criteria for interpretation of breast thermograms.

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■ **U.S.A.** Dr. Harold J. Isard was elected President of the American Thermographic Society in Atlanta, Georgia, on September 28th, 1975.

The present composition of ATS officers and executives is: H. J. Isard, M.D., President; G. D. Dodd Jr., M. D., Vice-President and President-Elect; A. Zermeno, Ph. D., Secretary and Treasurer; M. S. Lapayowker, M. D., Chairman of Executive Council; T. J. Love Jr., Ph. D., Budget Committee Chairman; H. I. Libshitz, M. D., Program Committee Chairman; M. Abernathy, M. D., Membership Committee Chairman.

Member-at-large: I. Barash, M.D.; M. Madsen, M.D.

Staff: Mrs. N.M. Oldfield, Executive Director.

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■ **CESENA (Italy).** The 2nd Course in Thermography was held from 1st to 4th of March 1976 at the Tumours Centre of Cesena Hospital.

The Course was organized by L. Rocchi, Head of the Tumours Centre. The programme was the following:

Introducing lecture: Thermography in vibrating tools (G. F. Pistolesi); *The physics of infra-red radiation* (G. Galletti); *The thermoregulation mechanisms* (L. Rocchi); *Thermography of benign lesions* (A. Parrella); *Thermography of malignant lesions* (L. Rocchi); *Comparison between thermography and mammography* (G. Viganotti); *Comparison between thermography and scintigraphy in the breast cancer screening* (P. Riva); *The problem of cold tumour* (L. Rocchi); *The problem of TH* 3 (L. Rocchi); *Thermographic follow-up of breast cancer after radiotherapy* (C. Altschuler); *Thermography on bone metastasis* (N. Cellini); *The mammary linfomas* (G. Viganotti); *Comparison between cytology and mammary thermography* (A. Parrella); *Workshops* (A. Parrella).

ROUND TABLE: *Health screening by thermography* (G. Landi - G. Viganotti - P. Riva - L. Rocchi - L. Lovisatti):

Scintigraphy of thyroid gland (P. Riva); *Thermography of thyroid gland* (L. Rocchi); *Thermography of bone tumours* (C. Altschuler); *Thermography of bone's* fractures (M. Boschetti); *Thermography* of joint *lesions* (L. Rocchi); *Dynamic thermography in plastic surgery* (A. Grisotti); *Workshops* (L. Rocchi); *The follow-up by thermography of thrombo-phlebitis* (G. Landi); *Scintigraphic and thermographic patterns of carotid insufficiency* (P. Riva - L. Rocchi); *Thermography in peripheral vascular diseases* (T. Marcatelli); *Thermography in head tumours* (L. Rocchi); Final lecture: Theoretical investigation and *practice in thermography* (A. Romanini).

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■ **BATH (England).** 9th - 10th April, 1976 a meeting of European Thermographic Association was held in Bath, organized by E. F. J. Ring from Royal National Hospital for Rheumatic Diseases.

The programme was as follows:

1) Teaching Commission. Under the chairmanship of Dr. Hessler (Lausanne) the commission is hoping shortly to have a detailed publication on thermography techniques and their clinical applications for teaching purposes. It was noted with deep regret that Professor R. Oliver of London, who was active on this commission recently died. A letter of condolence to his widow has been sent in the name of the members of the Association.

2) Terminology Commission. A defined vocabulary of terms is still in preparation which will, it is hoped, ultimately result in clearer understanding of the words used in the different European languages. A real effort is being made to only adopt those terms which are scientifically accurate and have no equivocal meanings on translation from one language to another. It is hoped that at the next meeting in November, assistants from the National Standards Organizations of the countries involved will be arranged. In preparing this dictionary of thermology the commission is endeavouring to supplement the formal definitions with more detailed information to assist readers who are not physicists.

3) Biothermology Study Group. Two half day meetings were devoted to emissivity and its effects on infrared thermography. Under the chairmanship of Professor Gouault (Rouen) Mr. Delis&e described the physical laws of radiation with reference to infrared thermography. Mr. P. Herve (Paris) described the new equipment for accurate measurement of the emissivity of skin and its variation with angle and wave length. Dr. J. Clark (Nottingham), grave a practical account of the various factors effecting clinical thermography with particular reference to errors by the mathematical model of the heat flow within a breast with a tumour, together with computed results for its behaviour under skin cooling ect. A discussion followed in which Dr. J. Steketee (Rotterdam) gave same measured emissivity values for the skin including the effects of cosmetics.

4) Sympasium on thermography in hone and joint diseases. This meeting was well attended. The papers given indicated the range of interest and the useful applications of thermography to this area of medicine. Some of the topics from this symposium are reproduced *in Acta Thermographica.*

5) European Thermographic Association Executive Committee meeting. It has been discussed about the preparations for the European Thermography Congress to be held in Barcelona in September 1978.

6) Social Programme. Included a concert given by the Herschel Ensemble including the music of William Herschel. Miss Caroline Herschel, the last relative of William Herschel to bear the family name, attended. The concert itself was held in the Octagon which was a formal chapel at which Herschel was the first organist and music director in 1766-1782.

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❑ **LOS ANGELES (U.S.A.).** The American Thermographic Society sponsored the First Regional Tutorial, scheduled on 19th and 20th June, 1976 at Los Angeles Marriott.

Medical Thermography applications to be covered include: breast cancer detection; stroke; peripheral vascular diseases; obstetrics and gynaecology, etc.

Faculty: I. Freundlich; H. Karpman; R. Gold: T. Winsor and others.

The faculty was joined by ATS industrial members who, with the aid of a technologist, discussed the technique for taking thermograms (AGA Corporation; Spectrotherm Corporation; Eastman Kodak Company: Polaroid Corporation and others).

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❑ **TOKYO (Japan).** The 8th annual meeting of Japanese Society of Biomedical Thermography and the International Symposium on Biomedical Thermography were held on 19th and 20th of June, 1976 at Kikaishinko Building, Shiba Park, Tokyo (President: K. Atsumi).

The programmes were as follows:

First scientific session: *The objective diagnosis of Raynaud's phenomenon* (M. Shingu et Al.); *The effect of local anaesthetics and vasoconstrictors on the temperature of the skin* (T. Suzuki et Al.); *Human thermal responses to a step change in ambient temperature* (M. Kawashima et Al.); *Thermoviewer type M.D.* (A. Masuki et Al.); *Development of new portable medical infrared thermometer with light indicators jor measuring area* (A. Nagasawa et Al.); *A study of skin temperature control* (I. Fujimasa et Al.); *Detection of breast cancer with the use of deep body thermometer* (Z. Yamazaki et Al.); *Thermal patterns of the normal breast analysed by thermography and infrared phlebography* (J. Yagamata et Al.); *Thermographic study in relation to the detection and prognosis* (I. Uchida et Al.).

Second scientific session: *Thermographic study on acupuncture anaesthesis* (K. Nishijo); *Thermographic study on oriental physiotherapy* (T. Matsumoto et Al.); *Quantitative thermal patterns in RA joints and the influence* of *antirheumatic agents on thermographic patterns* (M. Nagashima et Al.); *On the skin temperature of the face and the neck* (E. Takenuma et Al.); *Trial application of color thermogram in orthopedic diseases* **(T.** Kamano et Al.); *The thermographic studies on the lower legs in CVA patients with hemiplegia - 5th report.*

Invited lecture 1 (Chairman: K. Atsumi): *The current status of thermography in United States* (M. S. Lapayowker).

Invited lecture 2 (Chairman: K. Atsumi): *The current status of medical thermography in Europe* (N. J. M. Aarts).

Symposium: *The current status of biomedical thermography in Japan* (Chairman: K. Atsumi; Vice Chairman: Y. Sakurai; Special Commenter: N. J. M. Aarts; M. S. Lapayowker); *Biological application of thermography* (I. Fujimasa); *Physiological basis of thermography* (Y. Sakurai); *Deep body thermometer* (T. Togawa); *Cooperative diagnosis with thermography and other non-invasive methods*

(T. Nishisaka); *Health and thermography* (I<. Nishijo); *The thermographic studies of the lower legs in C.V.A. patients with hemiplegia* (K. Yanagi); *Thermography in collagen diseases* (Y. Miki et Al.); *The present status* of *thermography at a radiological department in Japan* (T. Itoh); *Recent survey of thermographic studies in obstetric and gynaecologic practice and its associated fields* (H. Suda); *Applications of thermography to oral surgery* (A. Nagasawa); *Present status of thermography in cancer research* (Y. Ohashi); *Thermographic studies on peripheral vascular disease and intestinal circulation* (Z. Yamazaki); *Thermographic study in dermatology and plastic surgery in Japan. Its present- status and future* (A. Munakata); *A review of thermographical studies on vibration syndrome in Japan (Y.* Naus); *Thermography in orthopedic surgery* (R. Kanie).

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■ **U.S.A.** « *Hot Spot* » published periodically from 1969 by the American Thermographic Society has now been replaced by « *Thermographic Quarterly* », Editor: David A. Winsor, M.D.; Associate Editor: Norma M. Oldfield.

Address: American Thermographic Society - 972, Washington Street - Gloucester, Massachusetts 01930.

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. **STRASBOURG (France).** A new review, called « *Senologia* », entirely devoted to breast disease problems, is edited by Strasbourg Team: Editor in Chief, Ch. Gros; Editorial Board, C. Annonier, B. Gairard, M. Gautherie, D. Gros; Editor assistants, Y. Hummel and G. Vetter; Secretary, B. Lux.

Address: Faculté de Medecine - 11, Rue Humann - 67085 Strasbourg.

An article of thermographic interest is published on the first number: M. Gautherie et al. (Strasbourg). *Thermographic aspects* of *mammary cyst.*

The second number of « *Senologia* » was issued on occasion of the Symposium on Non-cancerous Breast Diseases (Strasbourg 30th June - 3rd July, 1976), and contains the reports and free papers abstracts.

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❑ **STRASBOURG (France).** A Pre-Symposium organized by the College of Post-graduate Teaching in Radiology and devoted to the Post-graduate Teaching in Thermography, Ecography, Xero-radiography was held on June 28th, 1976, before the Symposium on Non-cancerous Breast Diseases (President: Ch. Gros; Secretary: M. Gautherie).

The following conferences about thermography were presented: **PHYSICAL AND PHYSIOLOGICAL BASIS METHODS:** Chairman; F. Halberg (Minneapolis); Co-Chairman: Y. Houdas (Lille); Secretary: Y. Quenneville (Strasbourg).

J. J. Vogt (Strasbourg): *Skin temperature and thermoregulation;* Y. Houdas (Lille): *Heat transfer within in vivo tissues;* F. Halberg (Minneapolis): *Thermal biorhythms;* Y. Quenneville (Strasbourg): *Infrared thermometry and thermography;* C. Huber (Paris): *Liquid crystal thermometry and thermography;* M. Gautherie (Strasbourg): *The thermographic information: origin, processing,* use; J. Bransier (Paris): *Definition and measurement of biothermal parameters (other than skin temperature).*

CLINICAL APPLICATIONS: Chairman: C. Hessler (Lausanne); Co-Chairman: E. F. J. Ring (Bath); Secretary: Y. Quenneville (Strasbourg).

R. Amalric (Marseille): *Skin diseases;* E. F. J. Ring (Bath): *Bones and joints diseases;* A. Le Treut (Bordeaux): *Peripheral vascular diseases;* J. Robert (Nancy): *Head and neck diseases;* L. Mallner (Lidingo): *Medical thermography* (film).

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■ **STRASBOURG (France).** The 5th Seminar of French Club of Clinical Thermography was held on June 29th, 1976, in connection with the Symposium on Non-cancerous Breast Diseases. At present, the Club has the following Board: R. Amalric (President); J. M. Spitalier (General Secretary); Th. Planiol, P. Marques, C. Lagarde (Vice-Presidents).

Address: Club Français de Téléthermographie Clinique - B. P. N°. 1 - 13381 Marseille Cedex 4 (France).

T.A. Thierrée (Paris) chaired the 5th Seminar, which was divided in two sessions.

In the first session (Chairman; F. Solsona, Zaragoza), the following proffered papers were presented: J, Dumoulin (Charleroi): *Thermography of the arterial diseases of lower limbs, before and after epidural infiltration;* M. Prats Esteve et al. (Barcelona): *Thermography in the control of sympathetic blockade of upper limb;* D. Giraud et al. (Marseille): *Thermographic evaluation of the action* of *cerebral vaso-dilator drugs:* R. Monteyne et al. (Gand): *Thermography in the varicocele; C.* Hessler et al. (Lausanne): *Thermography in Paget's disease treatment by human calcitonin;* G. F. Dacquino et al. (Milano): *Thermography in scoliosis;* D. Selig et al. (Strasbourg): *Quantitative thermographic study of vasomotor texts in dermatosis.*

In the second session (Chairman: M. Prats Esteve, Barcelona), the following proffered papers were presented: Y. Houdas et al. (Lille): *Comparison between infrared and liquid-crystal thermography;* A. Bellossi et al. (Rennes): *Echotomography and thermography in thyroid tumours;* L. Acciarri et al. (Verona): *Thermography of the salivary glands; Y.* Quenneville et al. (Strasbourg): *Thermography of the oral cavity and teeth;* M. Jaziri et al. (Tunis): *Clinical, radiological and thermographic patterns of 150 malignant breast tumours;* D.V. Fournier (Heidel.-berg): *Thermographic evaluations of growth rates in 53 primary breast carcinomas:* L. Puigdomenech Arisa et al. (Barcelona): *Thermogruphic results in 80 probable melanomas.*

Finally, two reports were presented: R. Amalric et al. (Marseille): Validity *of mammary thermography;* J.M. Spitalier et al. (Marseille): *Infrared rays against cancer.*

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■ **STRASBOURG (France).** Many reports of thermographic interest were presented at the 4th International Symposium on Senology, devoted to Non-cancerous Breast Diseases which was held in Strasbourg (30th June - 3rd July, 1976): President: Ch. Gros; General Secretary: M. Gautherie.

1) **Round Table** A, devoted to « Investigation methods »:

Reports: M. Gautherie et al. (Strasbourg): *Breast thermography. Basic and pathological patterns: examination policy.*

Free papers: B. Szigeti et al. (Montargis): *Infrared photographic study in non-cancerous breast diseases;* Y. Quenneville et al. (Strasbourg): *Breast impendance;* J. Tricoire et al. (Bobigny): *Flat plate thermography and diagnosis in breast di-*senses; L. Marie1 et al. (Bobigny): *Mastopathies: mastosic vascularization;* J. Y.

Pons et al. (Créteil): *Study of breast thermography variations with reference with clinical and biologycal parameter, in breast dystrophies;* B. Talia et al. (Modena): *Variations of the thermographic pattern of the breast during the menstrual cycle;* F. Rouanet-Rousseaux et al. (Marseille): *Estro-progestin hormones and breast thermography;* G. A. Bothmann (Heidelberg): *Correlations between clinical, mammographic and thermographic patterns. Prospective studies.*

2) **ROUND TABLE** C, devoted to « Mastopathies »:

Reports: R. Amalric (Marseille): *Fibro-cystic disease: radiography-thermography;* P. Bourjat et al. (Strasbourg): *Gynecomastia: radiography and thermography.*

Free papers: D. Giraud et al. (Marseille): *Breast cysts and thermography;* L. Thomassin et al. (Marseille): *Adeno-fibromas and thermography;* P. Galley et al. (Bobigny): *Inflammatory diseases of the breast;* L. Rocchi (Cesena): *Depistage* of *breast benign lesions by thermography.*

3) **ROUND TABLE** D, devoted to « Risks of cancer »:

Free papers: D. U. Fournier et al. (Heidelberg): *The clinical, radiological and thermographic risk group* of *14,000 patients with 582 breast cancers; G.* Otto (Berlin): *The prognostic value of the long-term follow-up by thermography in the positive or doubtful mammograms.*

4) ROUND TABLE E_1, devoted to **«** Treatments »:

Free papers: C. Altschuler et al. (Marseille): *Mammary prosthesis and thermography.*

5) ROUND TABLE E_2, devoted to « Hormonal treatments »:

Free papers: E. Lattanzio (Bari): *Clinical, radiological and thermographic study of the breast, during hormonal treatment.*

Abstracts of the papers presented at the Symposium on Non-cancerous **Breast** Diseases are available in the 2nd number of *« Senologia »,* **a new review, which we** give some information about, in these news.

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■ **WASHINGTON (U.S.A.).** The 7th annual meeting of American Thermographic Society will be held in Washington (D.C.) at the Hilton Hotel, on September **17th** and l8th, 1976.

Tentative programme of the first day is divided in two scientific sessions. The first session is devoted to *thermographic applications other than breast diseases.* Following arguments will be treated:

- *Thermography in pediatric orthopedic surgery. Possible areas of application - Application of color thermography to pediatric rehabilitation - The patho-anatomic basis for the abnormal thermogram in carotid disease - Dynamic thermography - The use of thermography in evaluating the efficacity of treatment programs in peripheral vascular diseases - Thermography in the assesment of bowel viability at surgery: preliminary report - Thermography: objective measurement.*

The second session is devoted to *breast thermography,* with the following reports:

- *Present status of breast thermography - Lack* of *efficiency* of *thermography as a screening tool for minimal and stage 1 breast cancer - Improved thermographic results in a mass screening project;*

- *Thermography: highest risk marker in breast cancer - A new color enhacement technique for the study of cancer of the breast - Quantitative breast thermography. A study of relationships between Amalric's classes and clinical parameters - Automated interpretation of breast thermograms - Preliminary date from ratio temperature measurements.*

Among those presenting papers will be: G. D. Dodd: M. Moskowitz; R. E. Nerlinger; W.B. Hobbins; ,I. Nyirjesy; E. J. Klink, Jr.; H. Roehrig; M.A. Rosman; R. Blank; R. H. Ackerman; M. L. Karpman; H. Y. Kresel; M. S. Lapayowker and T. W. Winsor.

On the second day, there will be two sessions in the morning and two in the afternoon with a tutorial programme, each led by an instructor and each to cover a medical application of thermography.

For further information and for registration, mail to: H. I. Libshitz, M.D., Department of Diagnostic Radiology, M.D. Anderson Hospital, 6723 Bertner Avenue, Houston, Texas, 77030 (U.S.A.).

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❑ **PARIS (France).** A Round Table devoted to the clinical use of Thermography, will be held on the 2nd of October 1976 during the post-graduate course for practitioners « Entretients de Bichat » at the Faculty of Medicine « Pitié-Salpêtrière » 105, Boulevard de l'Hôpita1, 75013, Paris.

President: R. A. Thierrée, Radiological Department, Necker's Hospital, 149 Sevres Str., 75730 Paris.

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■ **MONTREAL (Canada).** On the occasion of the foundation meeting of the « Canadian Thermographic Club », the first Canadian Symposium on thermography will be held at Mont Gabriel (Quebec) on the 16th and 17th of October, 1976.

The programme will be as follows:

A first scientific session devoted to breast thermography. A second scientific session devoted to non-breast thermography. There also will be a business meeting for the organization of the « Canadian Thermographic Club ».

President of the organizing committee: Dr. Roger Ghys, B. Sc., M.D., F. R. C. P. (C.), 10690 Avenue d'Auteil, Montreal (Canada).

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❑ **STRASBOURG (France).** Dr. M. Gautherie, General Secretary of the European Thermographic Association annonced the next issue of the first bilingual (English and French) digest intended for medical students, of the whole of Europe, with the following title: « Introduction to Medical Thermography ».

This digest is edited by the Commission on Teaching of A.E.T.

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■ **MARSEILLE (France).** The 6th « Days of Dynamic Telethermography » will be held at J. Pauli, 1. Calmettes Institute, 232 Boulevard de Sainte Marguerite, 13009 Marseille, on the 15th and 16th of October 1976.

The programme will be as follows:

On the first day: *Bases of dynamic telethermography* (R. Amalric); *Technique of examination* (L. Thomassin).

BREAST TELETHERMOGRAPHY PART 1: *Normal vascular patterns* (D. Giraud); *Classification of thermograms* (R. Amalric); *Cold cancers and fast-developing cancers* (J. M. Spitalier); *Diagnosis of extension* (B. Agopian).

BREAST TELETHERMOGRAPHY PART *2: Detection* of *sub-clinical forms* (J.M. Spitalier); *Surveillance* of *treated breast cancers; post-surgical* (D. Giraud); *post-*

radiation (R. Amalric); *post-hormone therapy* (C. Altschuler); *Benign breast tumors* (F. Mouton); *Mastoses* (F. Rousseaux); *Interpretation of breast thermograms* (D. Giraud).

CONCLUSIONS: *Senology* (J. M. Spitalier).'

On the second day the programme will be:

EXTRA-MAMMARY CANCERS: *Malignant skin melanomas* (J. M. Spitalier); *Bone and soft tissue sarcomas* (C. Altschuler); *Eye tumours* (R. Amalric); *Uterine cervix (Y.* Ayme); *Bone metastases* (L. Thomassin); *Other metastases and body thermovision* (J. Levrand); *Target volume determination* (F. Rousseaux); *Conclusion: D.T.T. indications in carcinology* (R. Amalric).

TELETHERMOGRAPHY IN NON-MALIGNANT DISEASES: *Traumatology* (C. Altschuler); *Peripheral vascular diseases* (D. Giraud); *Cerebral vascular diseases (C.* Altschuler); *Angyomes* (R. Amalric); *Bone and joint pathology* (L. Thomassin); *Plastic surgery* (F. Meline); *Conclusion: D.T.T. in non-malignant diseases* (R. Amalric).

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❑ **MADISON (U.S.A.).** The 2nd Annual Mid-American Breast Cancer Symposium will be held on 5th and 6th November, 1976 in Madison (Wis.), U.S.A.

This Symposium is convened in honour of Robert Egan, pioneer mammographer.

In the programme, some Sessions, devoted to thermography, are foreseen: N. J. M. Aarts (Tilburg): *A look at european breast cancer screening;* H. Isard (Philadelphia): *Thermographic patterns markers;* R. Byrne (Milwaukee): *Is thermography worth it?;* J. Nyirjesy (Bethesda): *A private thermography program in the screening.*

Workshops in thermography will be managed by R. Lawson (Montreal), R. Byrne (Milwaukee), N. J. M. Aarts (Tilburg) and H. Isard (Philadelphia).

Information secretary: Wisconsin Breast Cancer Detection Foundation, Inc. 7803 Mineral Point Road - Madison, Wis. 53717 U.S.A.

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. **PARIS (France).** The General Assembly of the European Association of Thermography, the 5th meeting of the Commission of Teaching and Nomenclature of the same association, the 3rd meeting on Industrial Thermography, the 3rd meeting of the Working Group on Biothermometrology will be held on 15th November, 1976, at Palais des Congres, Port Maillot, Paris.

General Secretary of A.E.T.: M. Gautherie, Faculty of Medicine, 11, rue Humann, 67085 Strasbourg (France).

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▪ **MARSEILLE (France).** The 6th meeting of the French Club of Clinical Telethermography will be an International Seminar and will be held in Marseille, from 23rd to 26th of May 1977. Chairman: J. M. Spitalier.

Official languages: French, English.

TOPICS: Thermographic prognosis of cancer - Thermographic' study of thyroid - Peripheral and cerebral vascular pathology - Osteo-articular pathology - Sub-clinical breast cancers - Dynamic telethermography in the world.

Information secretary: Club Français de telethermography - B. P.N° 179 - F 13275 MARSEILLE CEDEX 2.

NEW BOOKS

■ **MEDICAL THERMOGRAPHY**: this is not a very recent book, indeed it was published in 1973 by the University of Tokyo Press (7000 yen). Therefore it is possible that this book would not be adequately known in America and Europe. « Acta Thermographyca » feels justified in presenting it even though it is not new « sensu strictiori ».

The book has 380 pages with numerous figures; was edited by K. Atsumi from the Institute of Medical Electronics, Faculty of Medicine, University of Tokyo.

This book is devoted to reports presented at the 2nd and 3rd conferences sponsored by the Japanese Society of Medical Thermography in 1971 and 1972 respectively.

Thermographic activity in Japan is remarkable. The programme of the 8th conference is reported in the survey « Thermography in the world » held in June 1976.

25 Papers are reported in « Medical Thermography » of which 11 are devoted to the physical problems of infrared radiation and to the thermographic technique, 4 to heart diseases, 5 to vascular diseases, 2 to obstetrics and gynaecology and 3 to other clinical problems.

The following is the content of the book which should be present in all libraries of institutes working in thermography: *Medical thermography in* Japan (K. Atsumi); *Principles and requirements of medical thermography* (Y. Sakurai et Al.); *Some physical and physiological aspects of thermography* (I. Fujimasa et Al.); *Barnes thermographs* (H. Nemoto); *AGA Thermovision, thermography with real-time presentation (S. B.* Borg et Al.); *Infra-eye (a medical infrared image - producing apparatus)* (C. Fujii); *Medical infravision (S.* Ohno et Al.); *The model 6T01 thermotracer for medical* use (H. Ishiwatari et Al); *Construction and features of the thermoviewer* (A. Masuki et Al.); *Canon thermocamera* (Y. Koizumi); *Thermal recovery* (A. Nagasawa et Al.); *The application of thermography to oral surgery* (A. Nagasawa); *Some basic studies on breast thermography using phantoms for detection of tumours* (Y. Onai); *Thermography experiments on breast diseases* (Y. Nomura et Al.); *Clinical studies of the factors related to the thermographic diagnosis of breast diseases* (Z. Yamazaki et Al.); *The diagnosis of breast cancer by thermography* (Y. Ohashi); *Clinical application of infrared thermography to the study of Ruynaud's phenomenon in collagen diseases* (T. Hashimoto et Al.); *Thermography in peripheral vascular diseases* (Y. Mishima et Al.); *The application of medical thermography to peripheral vascular diseases* (Y. Nakanishi et Al.); *Thermometry in combination with lumbar anesthesia* (I. Yamaguchi et Al.); *Thermometer in the study of bloodflow circulation in skin tubes and flaps* (K. Arai et Al.); *Thermographic studies of congenital vascular malformations* (H. Azuma et Al.); *Application of thermography to obstetrics and gynaecology* (H. Suda et Al.); *Thermography during pregnancy* (S. Sakamoto et Al.).

□ THERMOGRAPHY OF THE BREAST: this book p. 190, by L. **Rocchi**, Publ. Costantini, Cesena (Italy), at a price of Lit. 15,000, in Italian language, was presented during the I National Congress of the Italian Thermographic Society, held in Trieste, in 18th and 19th May, 1976.

L. Rocchi, M.D., is Head of the Tumours Centre of Cesena Hospital (Italy) where an experimental Centre for breast Thermography is active.

Breast cancer mass screening by Thermography has been carried out in Cesena area from some years.

Doctor Rocchi's experience is therefore very extensive and his first book will be particularly useful to Italian thermographers; the beautiful reproductions make the book comprehensible also to not Italian thermographers.

The general index of the book is as follows:

Introduction

Physical and technical patterns of *infrared radiation thermography:*

1) the theory of irradiance, 2) relevation of infrared radiation, 3) the theory of temperature measurement by infrared radiation detectors, 4) description of an infrared apparatus producing a thermical image of the object.

Aga Thermovision 680 medical apparatus and relative accessories times of *observation.*

Physiological aspects of *thermoregulation:*

1) central thermoregulation, 2) variation of thermogenesis, 3) thermogenesis and surrounding air, 4) sex and thermogenesis.

Physiological variation of *breast thermograms*

Criteria for *interpreting breast thermograms:*

1) vascularization, 2) the vascular pattern in cancers, 3) the heat, 4) practical value of the edge sign.

Oncological classification

TH 1, TH 2, TH 3, TH 4, TH 5.

Benign mammary lesions

trauma, fibroadenoma, filloides cyst-sarcoma, papilloma, benign mammary dysplasia, acute mastitis, recovered mastitis, cysts, mammary hypertrophy, men's breast.

Thermography in the diagnosis of *breast cancer.*

The problem of *cold cancer.*

Thermography in the diagnosis of *breast cancer and its use in health screening.*

Our activities for *health screening.*

Comparative data between thermography and mammography.

Comparative data between thermography and cytology.

Comparative data between thermography and scintigraphy.