direct contact between erythrocytes and damaged blood vessels may be a factor in the production of burr cells (Brain *et al.*, 1962). Burr cells were present in all cases that we examined.

The peripheral blood film in our patients is therefore in many ways similar to that seen after removal of the spleen. In two patients the level of Howell-Jolly bodies was greater than that said to occur after splenectomy (0.3 % of erythrocytes) and was closer to the higher values (3.9–5.3 % of erythrocytes) which Fraser *et al.* reported in three cases of splenic atrophy associated with steatorrhoea.

The significance of these findings, we believe, is twofold. Firstly, the sequelae of Thorotrast characteristically occur after a long latent period—of the order of 20 years or more—and most patients are unaware that the injection has been made. In the absence of a history of splenectomy previous Thorotrast administration may be suspected when the peripheral blood film shows the changes usually associated with removal of the spleen. This is particularly so when haematological examination is otherwise normal.

Secondly, these changes may be indicative of a progressive loss of splenic function in patients exposed to Thorotrast. After intravascular injection the particles of thorium are phagocytosed by reticuloendothelial cells and are deposited mainly in the spleen and liver, and to a lesser extent in the bone marrow. Fig. 2 shows the appearances of heavy deposits of thorium in the spleen of a 33-year-old woman who at the age of 13 had 20 ml. of Thorotrast injected into the left carotid artery.

Attempts to estimate dosage to the spleen from the radioactive material deposited there are for technical reasons extremely difficult, but the dosage has been calculated by Rundo (1955) to be in the region of 1,100–1,300 rep¹ of α -rays and 130–150 rep of β -rays 20 years after an injection of 20 ml. of Thorotrast. As a result of this irradiation, and the interstitial fibrosis which follows the deposition of thorium in tissues, it is not unreasonable to postulate that over the years there will be a progressive loss of splenic function in these patients, and that this will underlie the peripheral blood changes we have described. The careful study and follow-up of such cases may therefore provide useful information regarding the effects of the

loss of splenic function and its possible role in some of the sequelae of Thorotrast administration.

Summary

Thirty-five persons who had received intra-arterial Thorotrast 11 or more years previously were examined. A consistent finding in films of peripheral blood was a disturbance of red cell morphology and the presence of Howell-Jolly bodies. In the absence of splenectomy, and when haematological examination is otherwise normal, such findings are extremely rare. It is thought likely that a progressive loss of splenic function has occurred in these patients as a result of irradiation and that this has caused the peripheral blood changes which we have described. More refined studies of splenic function in such patients are indicated.

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¹ Roentgen equivalent physical.

Association between Digital Ischaemia and Malignant Disease

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The association between thrombophlebitis and carcinoma has become well recognized since it was first described by Trousseau in 1865. The following cases suggest that there may be a similar association between digital ischaemia and malignant disease. Digital ischaemia as an early or presenting feature of malignant disease has not been described before.

Case 1

A woman aged 59 was well until December 1958, when severe pain developed in the left side of her face after the extraction of a left upper wisdom tooth. The left nostril was obstructed and discharged pus. After antral washouts these symptoms were to some extent relieved.

In February 1959, after taking a hot bath, she noticed that the index and middle fingers of the left hand had become numb and white. The left middle finger was painful, and there was an area

of discoloration at its tip, which later became black. A persistent pain, severe enough to prevent sleep, developed in the finger.

A year before this episode her right foot had become cold and white, and she had felt a pain in her right calf on walking uphill. Tolazoline hydrochloride was given by her doctor, and these symptoms soon disappeared. She habitually smoked 20 cigarettes a day. In 1949 she had had a gastroenterostomy for duodenal ulcer.

The severe pain led to her admission to hospital. On examination her general appearance was of good health, but there was a slight swelling of the left side of her face. The terminal phalanx of the left middle finger was black and dry. Adjacent to this was an area of painful erythema. The remainder of the finger was swollen and fixed in the extended position. There was a small area of discoloration on the pulp of the left index finger (see Fig. 1). Both fingers were colder than the other fingers of the left hand. Her blood pressure was 150/90, and the peripheral pulses, including the brachials and radials, were present and normal. There was no evidence of heart disease. Clinical examination was in all other respects normal.

Investigations.—Hb 67%. W.B.C. 10,200/cu. mm., normal differential count. No L.E. cells. E.S.R. 50 mm./hr. Electro-

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phoretic strip normal. Chest x-ray normal. X-ray examination of the thoracic inlet showed disc degeneration in the lower cervical spine but no cervical rib. E.C.G. normal. Arteriography revealed normally patent left subclavian and brachial arteries. A reactive hyperaemia test resulted in flushing of the whole of the left hand with the exception of the tips of the index and ring fingers and the middle finger distal to the proximal phalanx.

The condition of the left middle finger failed to improve and amputation was performed. Two weeks later left cervical sympathectomy was carried out. At operation two small soft plaques of atheroma were palpable in the subclavian artery but were not causing obstruction. After this operation she again developed pain

FIG. 1.—Case 1. Necrosis involving the terminal phalanges of the left index and middle fingers.

in the left side of her face. The left nostril was found to be occluded by a friable mass, which on biopsy proved to be anaplastic carcinoma arising from the maxillary antrum.

A course of palliative radiotherapy was soon discontinued, as the growth was not responding and was beginning to invade the orbit. She was discharged home on sedatives and analgesics, and died in June 1959.

Case 2

A woman aged 54 complained of coldness, numbness, and pain in the fingers of three months' duration. She first noticed her symptoms after she had been shopping on a cold winter morning. The distal two phalanges of the right middle finger had become cold, pale, and numb. These changes passed off with massage, but a few days later the tips of the fingers of both hands became painful and black (see Fig. 2). There were no changes in the feet and there was no history of sensitivity to cold or ingestion of drugs.

FIG. 2.—Case 2. Necrotic patches at the tips of the digits of both hands.

After admission to hospital for investigation she developed a low-grade fever for which no cause was found. She was then referred to University College Hospital, and while awaiting admission developed a right pleuritic pain and slight dyspnoea. She had had appendicectomy and cholecystectomy seven years previously and an attack of jaundice five years later. Otherwise she had been well. She smoked 10 cigarettes a day.

On examination she looked well. Her fingers were dusky and the skin was thickened. Black necrotic areas were present at the tips of all digits except the left little finger. There were areas of erythema and cyanosis and the fingers felt cold. Radial and ulnar pulses were absent in the right arm but present in the left. Leg pulses were present with the exception of the dorsalis pedis. Fundi were grade 0. B.P. was 140/90. There were no other cardiovascular abnormalities, and clinical findings, including pelvic examination, were otherwise negative.

Investigations.—Hb 92%. E.S.R. 72 mm./hr. Red cells normal. W.B.C. 6,600, with normal differential count. Blood urea 26 mg./100 ml. Plasma albumin 3.7 g., globulin 4.8 g./100 ml. Electrophoretic strip showed moderate increase of gammaglobulin and small increase of alpha-2 globulin. Plasma cholesterol 170 mg./100 ml. No cryoglobulins or excess macroglobulins. Serum cold agglutinins negative. No L.E. cells. Wassermann reaction and Kahn and Reiter protein complement-fixation tests negative. Catheter specimen of urine: red cells 3–5 per one-sixth field; pus cells 1–3 per one-sixth field; otherwise no abnormality. Chest x-ray examination: right pleural effusion, no cervical rib. Pleural fluid contained lymphocytes and red cells, but no malignant cells. Culture and guinea-pig inoculation negative. Pleural biopsy and bronchoscopy negative. Blood culture negative. Stool occult blood negative. Barium meal and follow-through normal. E.C.G. normal. A reactive hyperaemia test showed slight delay in the vasodilatation of the digital arteries.

While under investigation she developed a pleural effusion and recurrent fever. After four weeks her condition began to improve. Her right wrist pulses returned and the gangrenous lesions healed. Her pyrexia ceased, though she continued to lose weight. The cause of her condition remained obscure.

In view of her improvement she was discharged home. Within a few weeks she was readmitted in a confused and drowsy state and died shortly afterwards. At postmortem examination the upper two-thirds of the right kidney were replaced by a large hypernephroma. There were multiple brain secondaries but her lungs were clear. A secondary in the wall of the atrial septum and deposits in the right ovary were present.

Case 3

A woman aged 45 had undergone excision of the rectum for carcinoma in 1954. She was then well until September 1964, when a vaginal discharge occurred. Three months later she had an attack in which her fingers became dead-white and later blue. Since that time, on exposure to cold her fingers turned white, then blue, and then became red and tingled. Later her fingers remained persistently discoloured and painful, the symptoms becoming more severe during the course of each day, so that she was unable to use her finger-tips, though gangrene did not appear.

She had always tended to have cold fingers and had suffered from chilblains. Her general health was good. There was no family history of "Raynaud's disease," and she was a non-smoker.

On examination she looked fit and was not anaemic. Her fingers were blue and there were splinter haemorrhages under the nail edges. The peripheral pulses, including radials and ulnars, were palpable and normal. Her pulse was regular, B.P. 180/90, and there was no other cardiovascular abnormality. There was an irregular mass in the left hypochondrium and, per vaginam, the uterus felt bulky and fixed.

Investigations.—Hb 75%. W.B.C. 8,000, normal differential count. E.S.R. 43 mm./hr. Electrophoretic strip showed decrease in albumin and in alpha-1 globulins, but no evidence of cryoglobulins. Chest x-ray normal. X-ray examination of thoracic inlet showed no abnormality. A reactive hyperaemia test showed normal flushing of the upper limbs with the exception of the distal halves of the fingers of both hands.

Laparotomy was performed. There was a large mobile carcinoma of the splenic flexure. The uterus was bulky and there was a large cystic tumour of the left ovary. There were secondary deposits

in the omentum but not in the liver or peritoneum. Partial colectomy and a modified Wertheim hysterectomy were performed. Histology showed a primary carcinoma of the colon with metastases in lymph nodes, omentum, and ovary. The uterine tumour proved to be a primary carcinoma of the body.

She made a good recovery and remained well for some weeks, though the ischaemic changes in her fingers persisted. She was readmitted in July 1965 with carcinomatosis and died three weeks later.

Case 4

A woman aged 45 had been well until May 1957, when in the course of a brief illness, during which she suffered from a sore throat, diarrhoea, and generalized aches, she began to develop symptoms in her hands. Her fingers became numb and felt cold. Her original symptoms resolved but her fingers became painful and blue and then black at their tips. The fingers were slightly swollen and the skin began to flake off. She had had no serious illness and had not been unduly sensitive to cold. She was a non-smoker and there was no family history of "Raynaud's disease."

On examination she looked fit. The tips of the index and middle fingers of both hands were blue, cold, and tender. The changes originally noticed in the other fingers had resolved. All peripheral pulses, including the digitals and radials, were normally palpable. Her pulse was regular, the B.P. 200/125, and there was a soft apical systolic murmur. There was no other abnormality on clinical examination.

Investigations.—Hb 92%. W.B.C. 7,800, normal differential count. E.S.R. 12 mm./hr. Catheter specimen of urine normal. Cold agglutinins negative. No cryoglobulins detected. Electrophoretic strip showed small increase in gammaglobulin. Chest x-ray normal. E.C.G. normal.

Her symptoms resolved spontaneously and the cause remained obscure. She was readmitted in October 1957 complaining of a painful swelling in the lower abdomen. A tender mass arising from the pelvis was present. At laparotomy she was found to have a malignant left ovarian cyst. There were secondary deposits in the omentum, aortic glands, and liver, and the tumour was irremovable. Histology was that of a poorly differentiated adenopapillary carcinoma of the ovary. A course of palliative radiotherapy was given. She subsequently developed ascites and died shortly afterwards.

Case 5

A woman of 58 first attended hospital in June 1965, when she complained of attacks of pain, numbness, and pallor in her fingers which had started six months previously. These changes were first noticed in both middle fingers, and the attacks lasted about half an hour. Each attack would end with a tingling sensation in the fingers and a return to their normal colour without intermediate rubor or cyanosis. Gradually all the fingers distal to the proximal interphalangeal joints became affected, but the thumbs were never involved. The attacks, which became increasingly frequent, were usually precipitated by exposure to cold.

Shortly after the onset of these symptoms her sleep began to be disturbed by paraesthesiae over the flexor surfaces of her forearms and wrists and the lateral halves of her palms. Her fingers were not usually affected. These attacks were quite distinct from those brought about by exposure to cold. Her nocturnal symptoms were attributed to bilateral carpal tunnel syndrome. The diagnosis was supported by the finding of grossly abnormal conduction times in the median nerves. There was some response to hydrocortisone injections and splintage, but her digital symptoms continued.

In October 1965 she was admitted to hospital with dyspnoea, abdominal pain, nausea, and diarrhoea of three weeks' duration. She felt rather unwell with a vague abdominal discomfort for about one year. There was no significant family history and she did not smoke.

On examination she looked ill and was found to have a left pleural effusion and ascites. Her hands showed no abnormality and all peripheral pulses were present, including both brachials and radials. Her B.P. was 120/70, the pulse regular, and an apical systolic murmur was present. There was no abnormality in the C.N.S., and clinical examination was otherwise negative.

Investigations.—Hb 100%. E.S.R. 65 mm./hr. W.B.C. 8,000, normal differential count. Midstream specimen of urine normal. Sputum showed no malignant cells. No L.E. cells found. Serum

albumin 2.9 g., globulin 3.5 g./100 ml. Empirical liver-function tests normal. No cryoglobulins found. X-ray examination showed left pleural effusion and disc degeneration of cervical spine only. Barium-meal examination showed pyloric antrum displaced forwards, suggesting a retroperitoneal mass. Barium enema showed sigmoid diverticular disease. Both pleural and ascitic fluids contained malignant cells suggestive of adenocarcinoma. A reactive hyperaemia test showed normal vasodilatation as far as the proximal interphalangeal joints.

The ascites and pleural effusion were tapped and the fluids replaced by radioactive gold. Some delay in the reaccumulation of fluid was achieved by this means and she was discharged home, where she died in February 1966. Her primary neoplasm was presumed to be pancreatic or ovarian.

Case 6

A woman aged 42 was admitted to hospital in April 1953 complaining of persistent pain, tingling, and blue discoloration of some of her fingers. One week before admission the tip of the left index finger became blue and began to ache. Next day similar changes occurred in the left middle finger. The onset of these symptoms was quite sudden. However, for the previous two years, especially in cold weather, she had had episodes of numbness and pallor in her fingers. These changes occurred without warning and usually passed off after a few hours, sometimes assisted by the application of heat. Her feet also had often felt numb. In September 1950 she had been investigated after the discovery of consolidation of the right middle lobe of the lung. Also at this time a tumour of the parotid was excised. The cause of her chest lesion remained obscure.

On examination she was a frail woman who appeared to be in poor general health. The terminal phalanges of the left index and middle fingers were cold and blue, with a loss of sensation in the involved areas. The radial, ulnar, and digital arteries were all palpable. There was an enlarged gland in the right supraclavicular region and a varicose ulcer on the left leg. The foot pulses were palpable and there was no other cardiovascular abnormality. The signs of consolidation were still present in the right chest and the right kidney was palpable. The affected fingers made a slow recovery to normal colour with the exception of the top of the left middle finger, which became gangrenous. In hospital it was noticed that her other fingers had become transiently cyanosed.

Investigations.—Hb 78%. W.B.C. 12,000, normal differential count. E.S.R. 65 mm./hr. Sputum and gastric washings were negative for malignant cells and acid-fast bacilli.

The supraclavicular gland was excised, and proved to be involved by Hodgkin's disease. Review of the parotid tumour suggested that this also was Hodgkin's disease. She was given a course of radiotherapy to the neck region and mediastinum.

She was readmitted in July 1953 in an emaciated condition with polyarthritis and multiple enlarged glands. On this occasion her serum was found to contain cryoglobulins. Other investigations: W.R. and Kahn test negative; bone marrow normal; plasma protein showed marked rise in alpha-2 globulin and slight reduction in albumin; chest x-ray examination revealed persistent right middle lobe collapse.

Her condition did not improve despite treatment with A.C.T.H., cortisone, and nitrogen mustard. She died in November 1954. At post-mortem examination she was found to have widespread Hodgkin's involvement of hilar and aortic lymph nodes and glands in the porta hepatis.

Discussion

A few isolated reports have been published suggesting an association between digital ischaemia and carcinoma. The first was that of a young woman who in the summer of 1866 presented with blue, cold, and painful fingers (Fagge and Pye-Smith, 1891). She died in the following year, and at necropsy a growth was found infiltrating the first dorsal nerve and sympathetic trunk. O'Connor (1884) described the case of a middle-aged woman with gangrene of the tips of her fingers. She subsequently developed a mass of supraclavicular glands on

the left side which were thought to be metastases from a carcinoma of the breast. Before the onset of her digital symptoms a lump had been removed from the left breast. Pasteur and Price-Jones (1901) described the case of a man of 61 who in the terminal stages of carcinoma of the stomach developed cold blue extremities said to be like "Raynaud's disease." Hamilton (1920) saw a man of 54 with advanced carcinoma of the oesophagus who developed typical "Raynaud's disease." Bennett and Poulton (1928) reported the case of a man of 61 who developed "Raynaud's disease" the previous summer. He died during the performance of a cervical sympathectomy for severe pain, and necropsy revealed the presence of an occult carcinoma of the stomach. In these reports it is not made clear whether the digital ischaemia was persistent or occurred in attacks.

No further reports were published until Domz and Chapman (1961) described the case of a woman of 56 with digital ischaemia and gangrene of the distal third of the left index finger. She proved to have myelofibrosis, an adenocarcinoma of the lower lobe of the right lung, and cryoglobulinaemia. After resection of the tumour her digital symptoms resolved within a week and separation of the necrotic finger-tip followed within a month. More recently, Nielsen and Petri (1963) have described the case of a woman of 77 with symmetrical gangrene of the fingers. At necropsy she was found to have a malignant neoplasm of the colon with cervical metastases infiltrating the stellate ganglion. The authors thought that the digital necrosis was the result of vasospasm due to sympathetic irritation.

Raynaud's Phenomenon

Impairment of the circulation in the fingers has been well recognized since Maurice Raynaud published his first thesis entitled "Local Asphyxia and Gangrene of the Extremities" in 1862. It is clear that the cases which he described represented a number of different disease processes. Nevertheless the term "Raynaud's disease" gained common usage, and it is hardly surprising that it cannot be defined. Lewis and Pickering (1933-4) suggested that the term "Raynaud's disease" should be abandoned and that "Raynaud's phenomenon" should be retained, defining it as "the active and intermittent closure of small arteries of the order of digital arteries supplying the extremities." They described the changes in colour, temperature, and sensation that characterize the phenomenon. Many people experience the phenomenon without ever showing any evidence of structural change in the vessels, but, in some, structural changes occur and lead to nutritional changes and tissue loss. In addition to those patients with Raynaud's phenomenon in whom no predisposing cause can be found, these changes may occur in association with systemic illness. Recognized as giving rise to secondary forms of Raynaud's phenomenon are obliterative arterial disease, thoracic outlet syndrome, occupational trauma, collagen diseases (especially scleroderma), ergot poisoning, and haematological diseases (particularly where cryoglobulins and cold agglutinins are found) (Gifford, 1963).

Previous to the work of Lewis and Pickering it was widely believed that digital ischaemia occurring in association with malignant disease was due to the involvement of the cervical sympathetic trunk by neoplasm, with resulting peripheral vasoconstriction. Lewis and Pickering showed that the ischaemic changes could not be due to sympathetic overactivity but were attributable to local spasm of the digital arteries, which were shown to be unduly sensitive to cold. The essential feature of the phenomenon is that it is intermittent and the term should not be applied to permanent changes in colour, temperature, and sensation. Lewis and Pickering also described cases of bilateral gangrene of digits, and of particular relevance to the present paper are their two examples of a "curious malady" which "customarily starts without warning, several fingers or toes becoming discoloured within a period of several days. The part attacked is not affected transiently or intermittently, but remains discoloured until, after weeks or months, it recovers

colour, usually with loss of tissue at its end by a process of dry gangrene." In their examples there was no evidence of vascular disease proximal to the digital vessels, which they assumed on the basis of their tests to be thrombosed. It is our suggestion that an incident of this sort should alert the physician to the possibility of latent cancer. Lewis and Pickering and others have recognized digital ischaemia as a complication of advanced malignant disease but not as a feature of early or symptomless cancer.

Other Features

In the cases described above a number of features are worthy of mention. All of the patients were women and their digital symptoms were relatively late in onset, the youngest being 42 when first seen. None gave a previous history or family history of Raynaud's phenomenon. Symptoms were bilateral in five cases and affected two fingers on one side only in the other. In all cases the symptoms were sudden in onset and, with the exception of cases 3 and 5, rapidly progressed to gangrene. The site of origin of the primary tumour does not appear to be of significance: primaries were located in the maxillary antrum, kidney, and ovary respectively in three cases; one patient had carcinoma of both the colon and the corpus uteri; and in another case the organ of origin was not established but was probably the ovary or pancreas. In the remaining case the patient suffered from Hodgkin's disease. It is of interest that Case 3 had had a carcinoma of the rectum 10 years previously but at that time did not develop symptoms in her fingers. Three cases presented with digital symptoms; in the other three digital symptoms overshadowed earlier but milder symptoms which in retrospect were related to the underlying neoplasm. In Cases 3 and 5 the attacks of ischaemia were intermittent, but only in the former did the typical triphasic response to cold of Raynaud's phenomenon occur. In all others ischaemia was persistent though showing a tendency to improve.

There is no evidence that any of the predisposing conditions described by Lewis and Pickering were present in our series. Proximal arterial block could be excluded on clinical grounds in five cases, and in Case 1 an arteriogram showed the major vessels to be patent. In four cases reactive hyperaemia tests showed normal vasodilatation down to the proximal interphalangeal joints of the involved fingers. In those in which gangrene occurred, arterial occlusion is likely to have been caused by intense digital artery spasm, and this is supported by the fact that in some cases cold seems to have been a precipitating factor. Alternatively, ischaemia could have been the result of peripheral intravascular thrombosis. Venous thrombosis occurring in some forms of malignant disease is well recognized. Though the cause of this has not been established it seems at least possible that the same factors may operate to produce thrombosis in peripheral arteries in which the circulation has been rendered sluggish by cooling. Even so, it would be surprising if such a predisposition to thrombosis did not also show itself in episodes of phlebothrombosis. None of our patients developed symptoms or signs suggestive of venous thrombosis. It seems more likely that in those cases in which gangrene ensued vascular occlusion was the result of arterial thrombosis superimposed on spasm rather than the outcome of increased coagulability of the blood.

Vascular occlusion by emboli is unlikely in the absence of any discoverable predisposing lesion. In no case was there evidence of large-vessel or cardiac disease which might have given rise to emboli. It would also be difficult to explain the symmetrical and bilateral cases on the basis of embolism. There was no history of ergotism, and none of the patients had received drugs with vasoconstrictor effects such as methysergide.

Cryoglobulinaemia, a rare condition, may lead to intolerance of cold, peripheral gangrene, and allergic phenomena (Mackay *et al.*, 1956). These abnormal globulins can occur in multiple

myeloma, lymphoma, and occasionally in other malignant disease. It is of interest that in the case of Domz and Chapman (1961) resection of the tumour led to a fall in the level of circulating cryoglobulins. The level, however, remained high and the cryoglobulinaemia could have been due to the coexisting myelofibrosis. Waldenström (1961) found that in 276 unselected cases of macroglobulinaemia 10 suffered from malignant disease. He concluded that the finding of macroglobulins in any patient should warrant further investigation to exclude neoplasm. Bohrod (1957) thought that cryoglobulinaemia, which can occur together with plasmacytosis and urticaria, represented an immunity reaction between tumour and host. In our cases cryoglobulins were looked for in all patients except Case 1, and in her case the electrophoretic strip was normal. They were found to be present only in Case 6, who suffered from Hodgkin's disease.

On the basis of the six cases described above it is suggested that malignant disease may give rise to digital ischaemia, and this may be the presenting or the only symptom. How this occurs is a matter for speculation. The incidence of "Raynaud's disease" in the older age groups of the general population is not known. It is possible that the occurrence of attacks of blue and numb fingers in association with malignant disease was coincidental in cases 3 and 5. The presentation in the remaining four cases, in which necrosis was an early feature and the onset more or less sudden, is unusual enough to suggest a more than fortuitous relationship. All of these patients with the exception of the case of Hodgkin's disease died within 18 months of the onset of the ischaemic changes. In some the malignancy remained undiagnosed until the patient's death and in others was advanced when eventually discovered. Patients who present with digital ischaemia, often loosely termed "Raynaud's disease," in whom the accepted causes have been excluded, deserve the fullest investigation in an attempt to discover an occult neoplasm.

The variety of neoplasms described in our series would suggest that the search must be wide and may even necessitate laparotomy in certain cases. If thorough investigation proves negative a careful follow-up should be undertaken. In two further cases not described in this series, the patients presented with digital ischaemia and remained undiagnosed despite the fullest investigation. They were well at nine months and three years respectively from the onset of their symptoms. In such cases a careful follow-up should always be undertaken. If the possibility of occult neoplasm as a cause of digital ischaemia is

kept in mind diagnosis may be hastened and radical treatment made possible.

Summary

Six cases are described suggesting an association between digital ischaemia and malignant disease. They were a group of middle-aged women who either presented with atypical Raynaud's phenomenon or in whom this was a prominent feature. The symptoms were of sudden onset, bilateral in five cases, and in four rapidly progressed to gangrene. None of the commonly accepted causes of digital ischaemia was present. On investigation three patients were found to have a primary carcinoma of the maxillary antrum, kidney, and ovary, respectively; one patient had primary carcinomata of both the colon and corpus uteri, and in another the origin was not established but was probably the ovary or pancreas; the remaining patient was suffering from Hodgkin's disease. All of the patients with the exception of the last died within 18 months of the onset of the ischaemic changes. In some the malignancy remained undiagnosed until the patient's death and in others was advanced when eventually discovered. It is suggested that malignant disease may give rise to digital ischaemia and that it may be the presenting or only symptom. Patients who suddenly develop "Raynaud's disease" in whom the accepted causes have been excluded deserve the fullest investigation in an attempt to discover an occult neoplasm.

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Solar Retinopathy

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[WITH SPECIAL PLATE]

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Five cases of solar retinopathy presenting in Oxford within three months of the partial eclipse of 20 May 1966 are described.

Pathogenesis

Of the sum of solar radiation reaching the surface of the earth, only the visible and short infrared wavelengths reach the retina, the ultraviolet and longer infrared rays being absorbed in the cornea and lens (Verhoeff *et al.*, 1916; Irvine, 1945). The 60 to 70% of solar energy reaching the retina is absorbed by its pigment epithelium with the liberation of heat. With a meiosis of 2 mm., a 30-second exposure leads to the produc-

tion of heat at a rate of 70 calories/sq. cm./min., which is more than enough to produce a severe retinopathy experimentally (Verhoeff *et al.*, 1916; Ludvigh and McCarthy, 1938; Eccles and Flynn, 1944).

Exposure of pigmented rabbit retinæ to xenon arc photo-coagulator light has been shown to produce very similar lesions to human solar retinopathy, but similar exposures of albino rabbit retinæ were tolerated without damage, and ten times the dose was needed to produce equivalent burns (Geeraets *et al.*, 1962; Geeraets and Ridgeway, 1963).

Further experimental work with xenon and carbon arc photo-coagulators, the emissions of which are close to that of sunlight,