

Chapter 78

RADIODERMATITIS OF THE HAND

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By radiodermatitis is meant the changes in the skin induced by ionizing radiation. In the majority of cases the changes are caused by x-rays, which are used more commonly for diagnostic than for therapeutic purposes. Less frequently dermatitis is produced by radium plates or needles or by other radioactive elements such as iridium and strontium, which are also used therapeutically.

ETIOLOGY

Radiodermatitis of the hands is usually an occupational disease and is commonest among members of the medical profession: physicians, surgeons, radiologists, and dentists. Physicians and surgeons were represented in about equal numbers in our survey, exposure occurring during the course of repeated screenings in tuberculosis centers, or when a gastroenterologist palpates the abdomen to guide a gastric tube or endoscope. Surgeons are exposed as a result of multiple fracture reductions performed under radiological control or foreign body explorations without adequate protection.

Radiodermatitis occurs mainly as the result of a cumulative effect, even at long intervals between doses of radiation. This important fact is true even though cell growth may occur between exposures.

It is generally accepted that the average radiation tolerance of the skin is of the order of 0.2 rad a day. For a surgeon this would correspond to one minute of exposure every 10 days, on condition that the voltage does not exceed 80 kV. and that the intensity is

no greater than 3 milliamperes with an aluminum filter 1 to 2 mm. thick. The dose is then 2 rads per minute. How many surgeons are aware of these figures, and which surgeon can be certain that the time of exposure has not exceeded one minute, let alone the possibility of scattered radiation, which is far from negligible?

For over 15 years we and a number of other authors, including Pack (1939) and Lagrot (1964), have stressed the dangers of radiation during screening and have pointed out the errors of technique and faults in the equipment that can further increase these doses.

These undeniable facts are still being ignored by many. A dose of 400 to 500 rads leads to loss of hair and 600 to 1200 rads induces erythema. And how many of us remember the law that states that the radiation output varies inversely as the square of the distance between the source and the skin (and not between the source and the operative field)? Thus, if that distance is reduced from 50 to 10 cm., the skin receives as much radiation (i.e., 50 rads) in one minute as it would in 25 minutes of the "correct" exposure. In other words, the skin is exposed in one minute to a dose that would be acceptable if received in 250 days.

Let us quote Watson-Jones:

A number of surgeons have wrecked their careers as a result of reducing fractures under radiological control This is not an imaginary danger: it has actually happened to 91 surgeons. These figures refer only to cases reported in a single town and do not include non-orthopedic causes or minor cases I would like to forbid the use of radiological control in orthopedic sur-

gery. The risks are enormous and the advantages minimal. Ninety-one surgeons are known to have paid the price—try not to be the ninety-second.

It is difficult to make the point more clearly.

There is no valid reason for a physician or a surgeon to place his hands in a radioactive field. X-ray films of fractures should be taken by a qualified radiographer and can be developed within minutes. Preoperative screening is not essential when looking for foreign bodies provided there is a bloodless field and localizing views have been taken preoperatively. A single film taken during an operation will deliver 100 times less radiation than even a brief screening. The duration of the operation is not significantly increased and unjustifiable risks are avoided.

The dangers of radiation are obviously greater if the operator is not familiar with the equipment. Searching for a foreign body can be a lengthy procedure and delays can occur if the incision is too small, if localization has been inaccurate, if a pneumatic cuff is not used or simply if the surgeon is not sufficiently prepared.

Fluoroscopes, which are now in widespread use, have not reduced the risks significantly and cannot be regarded as a substitute for the usual precautions. Although in theory the brightness of the image can be considerably amplified (up to 1000 times with the more sophisticated devices) so as to reduce the irradiation required, in practice, amplification greater than 10 times is rare. Not uncommonly the amplification achieved is a bare twofold to threefold, which in itself is not negligible, although the benefit may be counterbalanced by an impression of false security and a tendency therefore to increase the time of exposure.

Radiologists, because of their familiarity with and constant awareness of the radiation danger, hardly feature in our series. Most cases reported in this speciality date from an earlier era.

Similarly dentists have also gradually dropped the old habit of holding the film behind the teeth, a task they now entrust to their patients.

Finally in the occupational group one should mention the rare cases of technicians who although fully conscious of the dangers involved, may fall victims to the diversification of sources and continuous modifications to the equipment. The legal precautions (as

defined in the Recommendations of the International Commission) are usually taken and accidents usually result from a faulty safety device. Accidental radiodermatitis in technicians is now about the only form of occupational radiodermatitis seen at an acute stage soon after exposure. One should always wait and follow the course of the disease. In certain acute forms (e.g., following irradiation by an electron beam) the condition may resolve spontaneously.

Nonoccupational radiodermatitis is much less common. However, because the same causes produce the same effects and because the radiosensitivity of the patient's tissues does not differ from that of the surgeon, the use of radiological screening in orthopedics and in explorations for foreign bodies can just as well result in radiodermatitis in the patient himself. We have seen a case in which acute radiodermatitis followed an exploration for a foreign body. Ulceration succeeded the acute phase, and malignant change to a basal cell carcinoma ended with an amputation after conservative surgery had failed.

Radiotherapy used against warts can have equally disastrous results. We saw the case of a woman who suffered ulcerating radionecrosis after radiotherapy for a wart on the dorsal aspect of the first interdigital space of the right hand. Malignant change led to amputation of the thumb and index finger, and after a recurrence the hand was amputated at the wrist.

Admittedly such catastrophes are encountered in only a minimal proportion of cases of warts treated with radiotherapy, but although amputation is rare, we have had to deal with more than a few patients in whom the complications of radiotherapy were undoubtedly far worse than the initial condition.

We do not intend to sit in judgment over the advisability of treating warts by radiotherapy, but we can confirm that this form of treatment is potentially more dangerous than it may seem and that it requires as much skill, and entails the same responsibility, as a surgical intervention.

Every surgical error is immediately obvious and can therefore be corrected, but an error in a radioactive dose may not be detected for years, by which time the diagnosis and treatment may be difficult.

Finally, a patient delighted with the result of a first course of treatment may request another course of the same therapy to treat a new crop of warts. If the areas treated

overlap, the risks of radiodermatitis are considerable even after an interval of years. We can only deplore the use of such powerful therapy against such a benign lesion. The same applies to all benign lesions of the hand, such as eczema and hyperhidrosis, for which radiotherapy is still advocated by some.

CLINICAL STUDY

It is sometimes, but by no means always, possible to diagnose radiodermatitis at an early stage. In an acute form of the disease, occurring within days or weeks after exposure, the signs are spectacular and easily recognizable: pruritus, bouts of erythema, and depilation are characteristic of dry radiodermatitis (Fig. 78-1). The exudative epidermal form (sometimes called "second degree" because of its similarity to burns) presents with blisters and painful ulcerations. Painful deep ulcers with well demarcated edges result from involvement of the dermis and dermal capillaries and are characteristic products of high doses of irradiation received during reduction of fractures or exploration for foreign bodies.

The date of onset is more difficult to determine when the only signs are those of a mild radiodystrophy developing gradually, sometimes years after exposure. Similarly an early diagnosis is uncommon in occupational forms when exposure is continuous and spread over many months.

In surgeons a frequent misdiagnosis is that of allergy to gloves, talcum powder, antiseptics, or alcohol. A benign useless treatment is prescribed, surgery is delayed, and exposure to x-rays is continued; in some cases a diagnosis of eczema is made and radiotherapy



Figure 78-1. Acute radiodermatitis.



Figure 78-2. Keratoses.

is prescribed. A faulty diagnosis therefore can have the most catastrophic consequences.

A single ulcer of recent onset and wrongly believed to be traumatic in origin may be the first sign of the disease. A search for the less obvious stigmata of irradiation and a detailed history should indicate the real etiology. In any form of radiodermatitis the latent period between exposure and the manifestation of its complications may be very long indeed; in one of our patients it was 38 years.

It is important therefore to know the early signs of radiodermatitis and to question the patient about past exposure. The disease may take the form of a mild dystrophy with or without the following: atrophy of the epidermis (a dry thin skin), sclerosis of the dermis (best demonstrated by palpation), discoloration of the skin (alternating areas of hyperpigmentation and depigmentation), keratosis (Fig. 78-2), telangiectasia and the less constant carbon spots (black patches caused by interstitial hemorrhages), and changes in the skin appendages (scanty or absent hairs; friable nails with characteristic longitudinal grooves (Fig. 78-3).

Excluding the cases of acute radiodermatitis and those which present with necrosis following an apparently quiescent dystrophy (Figs. 78-4, 78-5), the commonest presentation of the disease is a skin dystrophy to which may be added any of the following features—scabs, cracks, ulcerations, dyskeratosis, erosions, exudation, bleeding, desquamation, recurrent pruritus, and lesions due to the scratching of an already fragile epidermis (Fig. 78-6).



Figure 78-3. Nail lesions and tissue destruction on the middle finger. Pigmented deposits and cracks occur on several digits.

The diagnosis of radiodermatitis is simple if malignant change is obvious (Fig. 78-7). It should be suspected if ulceration is present; at an earlier stage it can be made only by histological examination.

The site of the lesions depends on the source and direction of the irradiation. In our series the disease was three times more common on the dorsal than on the palmar side.

The extent of the dermatitis is extremely variable. Of 70 cases of radiodermatitis of the hands in our study, 22 were bilateral (of which 19 were occupational); the lesions were often more marked on one side (usually the left). In 21 cases four fingers were involved and in 14 cases, three fingers only. Involvement of the thumb alone was seen in six patients, of whom two were radiologists and two were physicians.



Figure 78-4. Severe radionecrotic ulceration.



Figure 78-5. Radiodermatitis of the dorsum after foreign body extraction.

CLINICAL COURSE

The course of the disease is somewhat unpredictable. Ulceration may start in a dystrophic, quiescent looking area; it may heal by scarring as a result of, or in spite of, topical therapy and reappear indefinitely or at least until surgery is performed. One should not be deceived by these periods of remission. This is a progressive condition: the underlying thrombosing angiitis is irreversible and can only extend. But necrosis with concomitant severe pain and risk of infection, is not the only complication.

The major long term risk in any form of radiodermatitis is malignant change, which many authors regard as inevitable (Fig. 78-7). Of our 70 patients with radiodermatitis of the hands, 14 (20 per cent) sustained malignant change—a figure comparable to those



Figure 78-6. Chronic progressive radiodermatitis after irradiation of warts.



Figure 78-7. Large squamous cell carcinoma following irradiation during foreign body removal.

of Pack (1939), Rintala (21 per cent), and Mouly and Bureau (1970; 15 per cent).

Several histological forms of malignant disease occur, the commonest being squamous cell carcinoma (nine of 14 in our series, four of which progressed to invasion of regional lymph nodes). Basal cell carcinoma is rare (one case only). Bowen's carcinoma in situ (three cases) is probably an early form. Adenoacanthomas are also rare (one case) and are not malignant.

Invasion of lymph nodes seems commoner in squamous cell carcinomas occurring in the hand (one in seven according to Mouly and Bureau, 1970). This does alter the prognosis, but the incidence is probably less than was once believed: Of our four patients with axillary node involvement, only one died from the tumor.

The etiology of malignant tumors secondary to radiodermatitis of the hand in our series is worth mentioning. Twelve were occupational: nine physicians, two radiologists, and one radiographer. One followed an exploration for a foreign body. One followed radiotherapy for warts.

These findings confirm the carcinogenic action of repeated small doses, although it may be misleading to regard such doses as small. Lagrot (1964) mentions the case of a technician who reassessed the doses to which he had been exposed and reached the unlikely figure of 35,775 rads.

Carcinomas secondary to radiodermatitis of the hands have a notorious tendency to recur, even after wide excision. There may

be three reasons for this: The tumors are often multifocal, the cause of the tumor (previous irradiation) is still present and further malignant change is always possible, and the tumor elicits little or no stromal reaction.

TREATMENT

The only form of curative treatment is surgery. It was not long after the discovery of x-rays by Rontgen in 1896 that Charles Allen Porter first operated in a case of digital radiodermatitis. In some cases of dystrophy that appear to remain quiescent, surgery can be postponed indefinitely as long as the lesion is kept under close watch and further exposure to x-rays is strictly forbidden. However, radical surgical treatment is almost always justifiable for radiodermatitis of the hands. The lesion should be excised like a tumor and replaced by a free graft.

The earlier the diagnosis is made and surgery performed, the better the results. The proportion of postoperative complications, failures, and reoperations in relation to the age and stage of the lesions is significant.

In young patients the indication for surgery is even stronger in view of the greater risks involved. For small lesions, electrocoagulation may sometimes be tried, and superficial lesions occasionally can be treated by dermabrasion (although the involvement of deeper layers is often not evident). In the majority of cases, however, excision and grafting remain the treatment of choice.

The operation is performed under general or local anesthesia combined with hypnoanalgesics (Fig. 78-8). A pneumatic cuff on the arm or an elastic cuff at the root of the finger is often used. Recently we have preferred to avoid the use of a tourniquet and to reduce the bleeding by subcutaneous infiltration with a local anesthetic (procaine or lidocaine) combined with epinephrine (1 in 10,000).

The excision is particularly delicate over the distal interphalangeal joint where the insertion of the extensor tendon lies close to the matrical zone. If the nail is dystrophic, it should be removed together with the matrix and nail bed. If the nail appears to be viable, one may be tempted to be conservative while remaining aware of the fact that the pathological process may continue.

The viability of the tendon is usually more difficult to assess. If the chances of survival

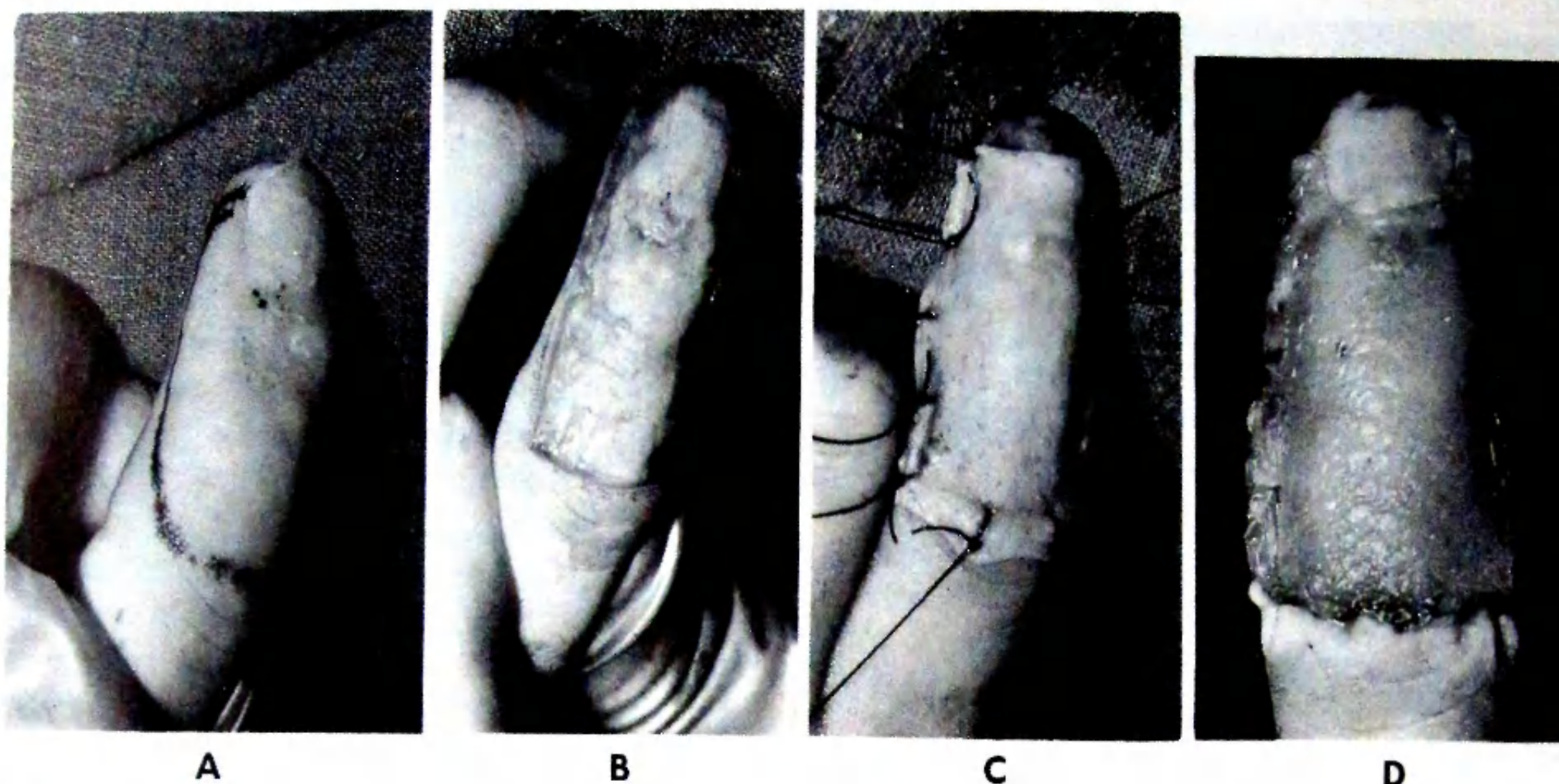


Figure 78-8. A, Extent of excision. B, The damaged tissues have been removed and the nail preserved. C, An overlapping full-thickness graft sutured in place with nonabsorbable material. D, The graft on the thirteenth day.

are poor, the area may be covered with a flap from a distance (or rarely a heterodigital flap) with a view to undertaking a tendon repair at a later stage. A skin graft will not prevent the tendon from rupturing usually at its insertion, either spontaneously or following a minor injury.

THE REPAIR

The pathological area is excised and grafted over at once. The palm receives a full thickness graft, but surgeons vary in their preferences for the dorsum. Some advocate a full thickness graft in spite of the lower chances of its taking, whereas others prefer a thinner one, which they believe will provide a more supple skin covering.

The graft should be carefully sutured in place either with nonabsorbable material or with catgut, the latter carrying the advantage that suture removal will not be required in this sensitive area. It is then held in place with a tulle gras and stockinette dressing. The dressing is changed on the second day in order to evacuate early any collections of serum or blood, which may separate the graft from its bed. If these are left longer, the graft may never become established.

Incomplete taking of the graft is a not uncommon postoperative complication. It may occur even in the absence of a hematoma and is then probably due to inadequate vascularization of the graft bed. Cicatrization

may still occur in areas where the graft has failed to take, as though the trophicity of the bed has somehow improved under the loose graft. If this is delayed, however, a complementary graft is advisable.

In the majority of cases treated at the stage of simple radiodystrophy, the graft will settle and provide a mobile digital tegument (Fig. 78-9). In some cases of deep necrosis an autoplasty may be required.

A local flap can seldom be used because adjacent tissues have also been irradiated (though to a lesser degree) and do not readily tolerate migration. Cross finger flaps are possible only for small lesions and if the adjacent finger is healthy. Brachial and thoracic flaps are used as a last resort if preservation of the digit is functionally indispensable.

Depending on the lesions, a nail, one or two phalanges of one or more fingers, a whole digital column, or the whole hand may have to be amputated. One should strive to be as conservative as possible and think in terms of function as well as of cosmetic appearance (e.g., amputation of the metacarpal when the corresponding digit has been sacrificed [except if a broad hand is desirable for professional reasons] to produce an acceptable hand with three fingers and a thumb. The extent of the amputation depends partly on the histological findings and partly on the functional possibilities of the digit to be spared.

A histological examination of the whole specimen should be requested in all cases. Once excised, the specimen should be re-

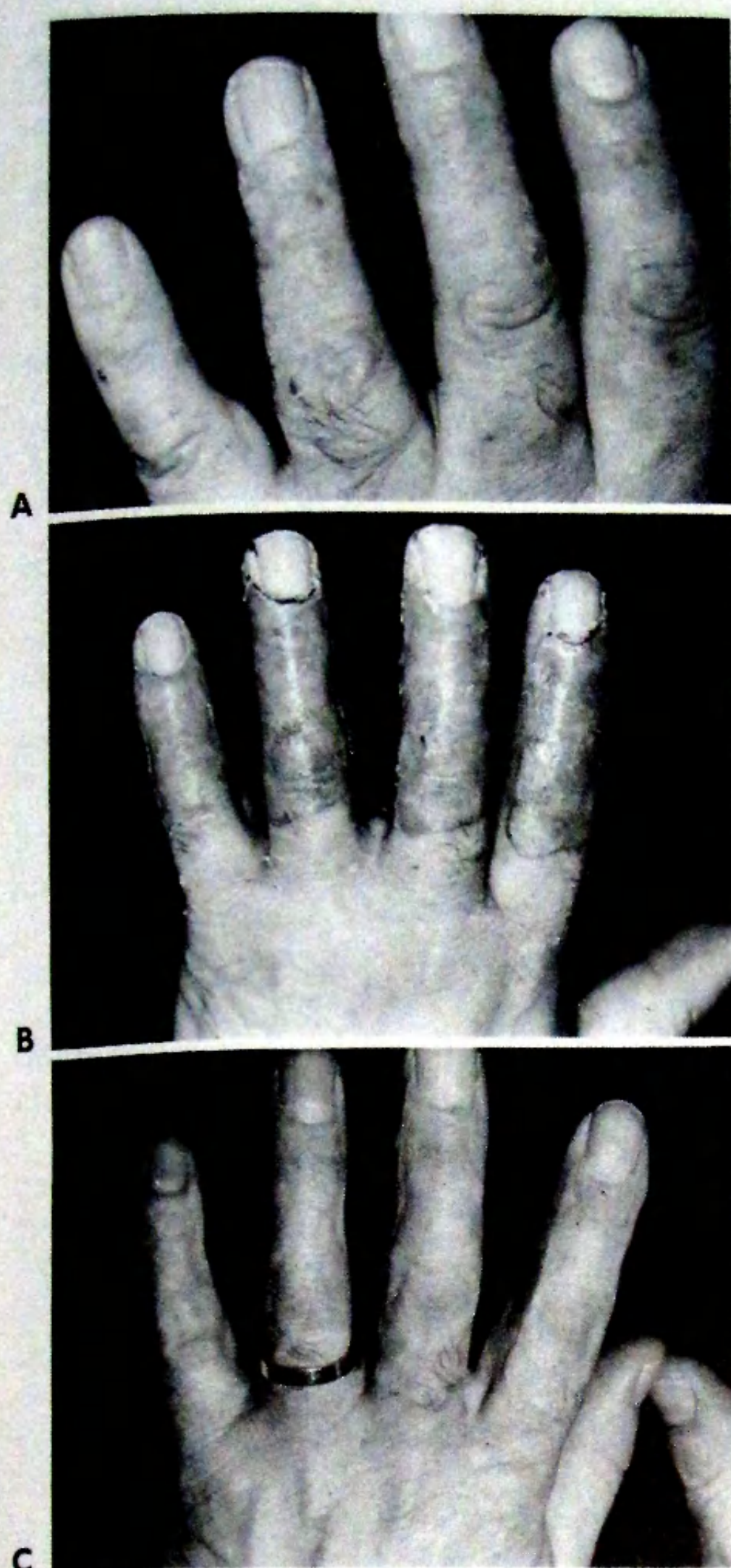


Figure 78-9. A, Radiodystrophy of the four fingers. B, The hand on the fifteenth postoperative day. C, The same hand five years later.

oriented digit by digit and the suspicious areas marked to ascertain that the line of excision has not crossed a potentially malignant zone.

TREATMENT OF MALIGNANT CHANGE IN RADIODERMATITIS

Two types of cases must be considered in cases of malignant change:

1. When malignant disease has been missed clinically and discovered only during histological examination, usually the excision will

have been wide enough and it will suffice to keep a close watch. However, if histological examination has revealed the excision to be inadequate, it should be extended as early as possible.

2. When the malignant nature of the lesion has been diagnosed clinically, the mere presence of malignant change does not necessarily imply an amputation. However, there are cases in which the extent and depth of the lesion, joint stiffness, and major trophic changes condemn the digit or the whole hand. Radical surgery should be avoided, however, because a number of malignant lesions following radiodermatitis of the hands can be treated safely by excision and grafting alone.

Amputation becomes a necessity if such a malignant lesion recurs, together with a block dissection of the regional lymph nodes if lymphatic spread has occurred.

On the subject of treatment, we would like to make two observations:

1. In occupational radiodermatitis the diffuse nature of the lesions and their multifocal origins mean that reoperation is frequently required.

2. Each digit should be treated according to the nature and stage of its lesion, as, for example, in the case of a hand in which three adjacent fingers were involved to different degrees; the middle finger was amputated, the index finger was covered with a flap from a distance, and the ring finger was treated by excision and grafting.

We can conclude this section by again stressing the importance of prophylaxis in this relentlessly progressive condition. We would like to see discontinuation of the use of radiological screening, a practice fraught with danger for doctors and patients alike. Patients undergoing radiotherapy (and the public in general) should be better informed about the importance of previous irradiation. Finally more judicious use of x-rays should be the rule, although their undeniable diagnostic and therapeutic value is somewhat counterbalanced by the advertisement of radiotherapy as a universal and painless panacea, which is wrongfully prescribed, even in young patients, to treat benign lesions.

In this field in which complications may develop long after the initial injury, everyone should learn from the experience of others. Otherwise there is a real danger that radiodermatitis may remain a topical subject for years to come.

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