Trichophyton Tonsurans (Crateriforme) Infection of the Scalp

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SUMMARY

Of 484 cases of ringworm of the scalp observed in a period of two and a half years at a clinic in Los Angeles, 57 (11.78 per cent) were caused by Trichophyton tonsurans, an organism previously considered an infrequent cause of tinea capitis in the United States. The hairs at the site of infection with this organism are distinctively fluorescent when viewed under a Wood light—glowing white rather than green as do hairs infected with microsporum. Endothrix spore formation may be noted in microscopic examination of infected hairs. Material planted on Sabouraud's media grows as a typical crateriform colony. Occasionally variant growths on cultures are obtained.

Trichophyton tonsurans may cause either dry, scaly lesions or inflammatory reaction. In the present series the incidence of cure was higher and the period of treatment shorter for patients with the inflammatory variety. Various antifungal preparations were employed for topical application and although the results were extremely variable, it was felt that some benefit was derived from their use. For lesions of the dry, non-inflammatory type, roentgen ray epilation appeared to be the treatment of choice.

DURING the past decade throughout the United States considerable attention has been focused on tinea capitis, which in many localities has assumed epidemic proportions. The specific fungus responsible for the "epidemic form" is the Microsporum audouini (human type). Of lesser epidemiologic importance and causing relatively fewer infections is the Microsporum lanosum (animal type). These two species of Microsporum were the agent in the great majority of the cases recently reported. A few of the reports[2, 3, 7] listed a small percentage of the cases as caused by various species of Trichophyton. Because of the few patients available for study, there is little in the American literature about trichophytosis of the scalp, and, more specifically, tinea capitis caused by Trichophyton tonsurans. Therefore, when quite unexpectedly many children with Trichophyton tonsurans infection of the scalp were observed, the opportunity for study of this uncommon variety of tinea capitis was welcomed.

This kind of ringworm of the scalp, which has always been considered a rarity, is now prevalent in the Los Angeles area. Fifty-seven cases were observed at the Southeast Tinea Capitis Clinic of the Los Angeles City Health Department in a period of two and a half years. In the same period, 36 cases were observed at the Health Department's Central Tinea Capitis Clinic.

Trichophyton tonsurans infection of the scalp was first clearly delineated from other forms of ringworm in 1844 by David Gruby.[4b] In 1845 Malmsten[10] described the same condition and suggested the name *Trichophyton tonsurans* for the causative organism. Both Gruby and Malmsten had reported that the infected hairs were filled with spores but it remained for Sabouraud,[13] nearly 50 years later, 1894, to grow the fungus on special media. Sabouraud named the organism *Trichophyton crateriforme*. Priority, however, has been given to *Trichophyton tonsurans*.

This variety of ringworm has been well known in England,[6] France[13] and other European countries,[9] but in the United States has never gained a foothold. Although a survey of recent reports from areas where tinea capitis is rampant indicates the rarity of this kind of infection,[1, 14, 9] with shifting of populations at this time it would appear that conditions are ripe for a country-wide epidemic similar to that which was caused by Microsporum audouini about ten years ago.

CLINICAL MANIFESTATIONS

Although tinea capitis caused by Trichophyton tonsurans can often be recognized from the clinical manifestations, Wood light examination (inspection in a darkened room under filtered ultra-violet rays) is of further help in diagnosis. Even so, definitive diagnosis depends upon mycologic examination.

As in Microsporosis, the disease is characterized by the formation on the scalp of single or multiple baldish scaly patches which may be dry and not inflamed, or inflamed in variable degree. The individual plaques are usually discrete, circular, and from 0.5 to 6.0 cm. in diameter (Figure 1). Occasionally, larger areas are encompassed by the confluence of adjacent small patches. Usually, however, the individual lesion caused by Trichophyton tonsurans is less well outlined and tends to be smaller than that of microsporosis. Early in infection the lesion is similar to the annular lesion characteristic of tinea circinata, with a prominent, sharply marginated raised border. At this stage there is little loss of hair; and it is only in this stage that the term "non-fluorescent ringworm"[8] is applicable, for under

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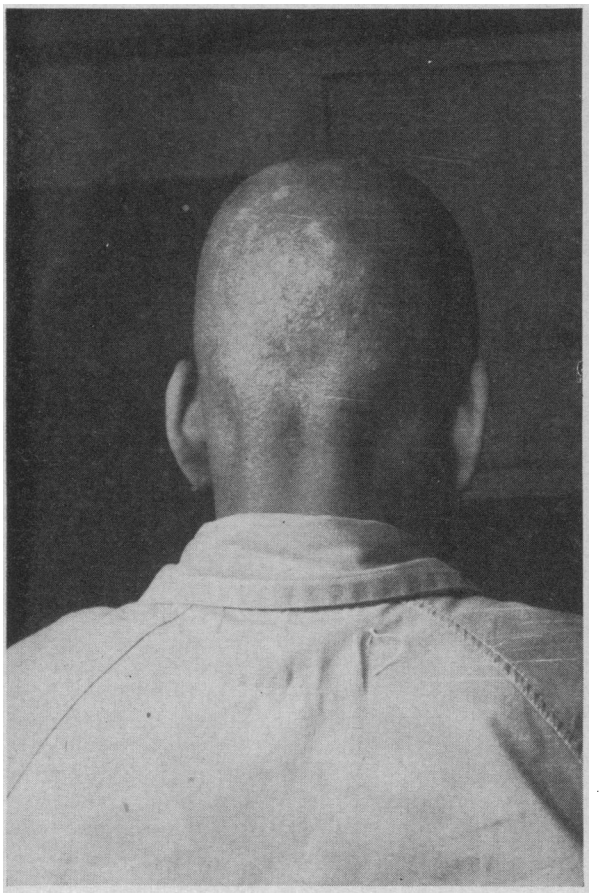

Figure 1.—Multiple small, dry patches of alopecia with slight scaling. Trichophyton tonsurans infection, non-inflammatory.

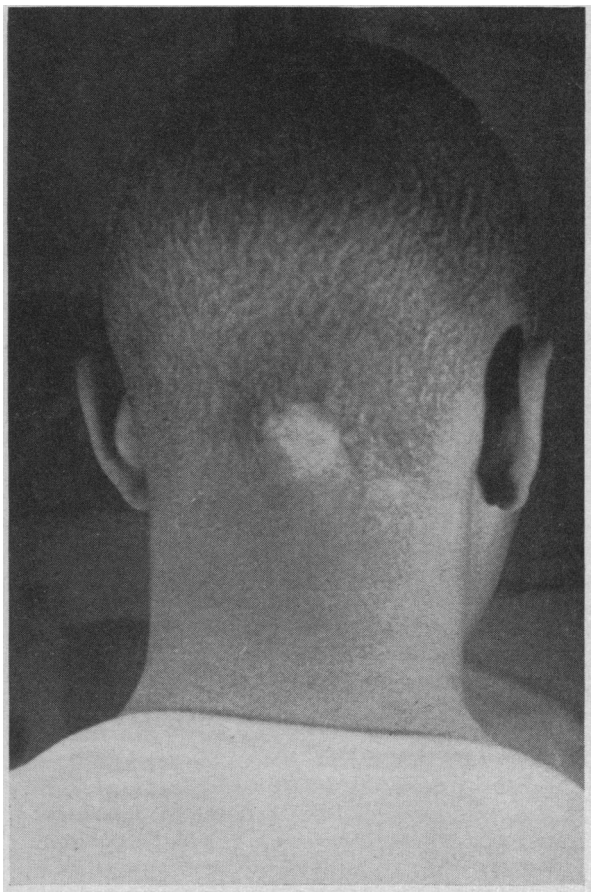

Figure 2.—Residual bald patches of involuted kerion caused by Trichophyton tonsurans.

the Wood light the hairs appear normal.* As the disease progresses, the infected hairs break off at the surface of the scalp, although characteristically a number of longer, normal-looking hairs remain in the otherwise bald patch. A grayish-white thin scale covers the surface. Upon examination under magnification, some short, thickened hair stubs projecting 2 to 3 mm. above the surface, and many minute keratotic follicular papules may be noted. Within each papule is an incarcerated twisted hair.

Inflammatory reactions are common. They vary in degree from slight edema and erythema with oozing and crusting to deep, draining abscesses and phlegmons (kerion). Frequently a few inflamed follicular papules or pustules are present in an otherwise dry and non-inflammatory patch. Extension of the inflammatory process may involve other follicles in the patch, and thus progression through stages of development from superficial perifollicular reaction to the production of true kerion may occur. As a consequence of inflammation, smooth, shiny atrophic depressed plaques bearing a close resemblance to the lesions of alopecia areata result (Figure 2). Regrowth of hair, however, usually takes place, although some scarring and partial alopecia may result. No patient in the present series had permanent complete alopecia.

* The term "non-fluorescent ringworm," as applied to Trichophyton tonsurans infection of the scalp to differentiate it from Microsporum infections, is actually a misnomer. The infected hair stubs and plugs in the former give off a white fluorescence in contrast to the brilliant green of the infected hairs of the latter.

WOOD LIGHT EXAMINATION

The appearance of the infected scalp under filtered ultra-violet rays is quite distinctive and, in the authors' experience, usually diagnostic. Whereas in microsporosis the infected hairs emit a brilliant green fluorescence, in Trichophyton tonsurans infections each involved follicle is identified by a dull to gleaming white scaly plug filling the orifice. Removal of the plug exposes an attached and imbedded short hair. If the hair has escaped incarceration in the mass of keratin, it projects through the follicular plug as a thickened white stub. When the plug or protruding hair is extracted, the intrafollicular portion can be faintly visualized but it does not fluoresce. Fluorescence is due to the keratin scale which fills the follicular orifice and which also extends as a sheath along the extrafollicular portion of the hair. Frequently, extensive involvement is noted under the Wood light in cases in which clinical inspection indicated only a few areas of infection. Very small spots involving only a few follicles can readily be identified under the Wood light.

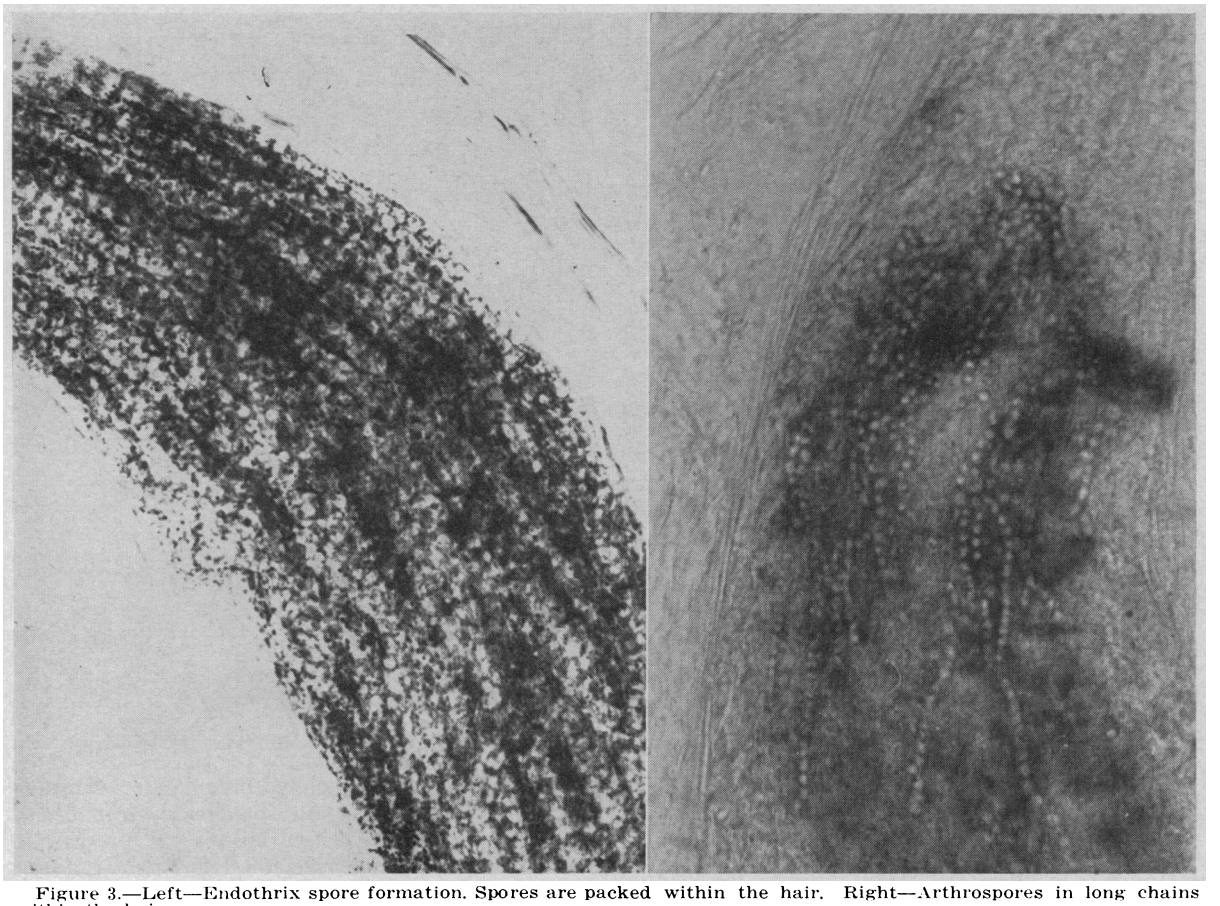

Figure 3.—Left—Endothrix spore formation. Spores are packed within the hair. Right—Arthrospores in long chains within the hair.

MYCOLOGIC CHARACTERISTICS

If a microsporic hair, after suitable preparation in sodium hydroxide solution, is viewed under a microscope, ectothrix spore formation characteristic for microsporosis may be observed — oval or round refractile bodies, 2 to 4 micra in diameter, densely packed, forming a sheath which encloses the hair from just above the bulb to varying distances on the broken shaft. This sheath corresponds to the fluorescent green area seen under the Wood light.

In Trichophyton tonsurans infection, the interior substance of the diseased hair is filled with a mass of spores united in chains, running parallel to the long axis of the hair (Figure 3). The spores are larger, 4 to 6 micra in diameter, and tend to be quadrangular in form. Where the hair has been unable to penetrate through the follicular plug, it lies embedded in a mass of keratin, assuming a twisted, spiral *S* or *Z* shape (Figure 4). Those hairs which project beyond the follicular opening are covered in the extrafollicular portion by a keratin sheath. Spores are not present in the sheath except when the cortex of the hair breaks and spores spill out from the interior. In very early infection, before any appreciable scale develops, the involved hairs appear normal and are not fluorescent, even though they are filled with spores.

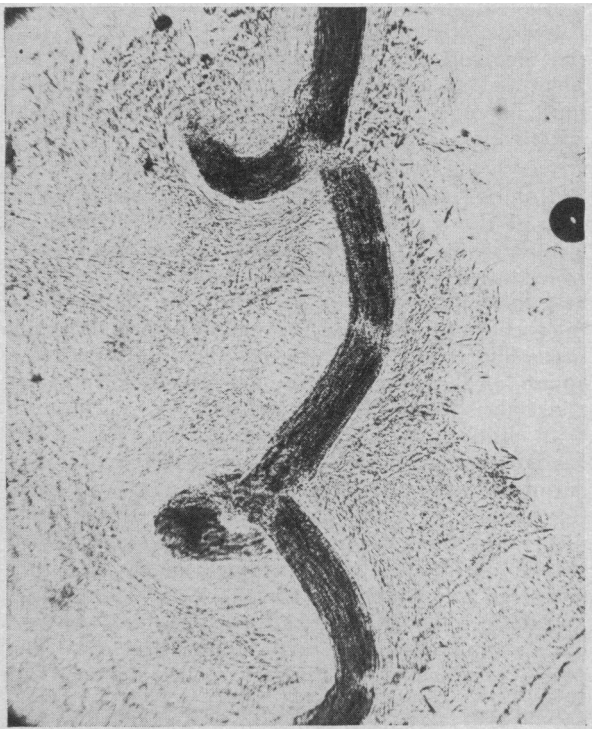

Figure 4.—Twisted degenerating hair imbedded in follicular scale. Spores spill out where the hair breaks.

CULTURAL ASPECTS

On Sabouraud's glucose agar media, growth of Trichophyton tonsurans begins as a white fluffy patch which extends peripherally. Later the colony becomes more compact and develops into a flat, velvety, cream-colored disk. The center of the patch sinks and the edges become elevated, thus forming the characteristic crater from which derives the term *crateriforme.** Frequently a small knob appears at the bottom of the crater. Surrounding the walls is a white mycelial fringe growing out into the media. The surface of the colony takes on a deepening cream to beige powdery appearance as it ages. The gross morphologic characteristics are distinctive; typical colonies, as described, are readily identified (Figure 5). Early in the investigations in the present study, however, it was noted that some of the growths obtained differed considerably from the typical crateriform colonies. In some instances there was so much variation from the typical in color, folding and crater formation that it was felt the organisms were of other species. In microscopic features, these aberrant cultures were similar to each other and to typical cultures of Trichophyton tonsurans. Attempts to identify these variant cultures with the specific organisms described in the various texts and references under such names as T. acuminatum, T. cerebriforme, T. sulfureum, etc., were fruitless. The descriptions given by various authorities were found to be vague and inadequate and frequently in conflict. Letters and cultures were dispatched to a number of leading mycologists in this country for aid in this problem. In every instance the replies indicated that the same difficulty in identification existed in other quarters.[12] The consensus of many American mycologists at present seems to be that the members of the crateriform group cannot be identified accurately as to species, and in general must be considered as strains of Trichophyton tonsurans.

DIFFERENTIAL DIAGNOSIS

Differentiation of Trichophyton tonsurans infection of the scalp from other conditions which resemble it should not be difficult if the Wood light procedure, the microscopic examination of the hair, and the culture method are utilized. The common microsporum infections are readily identified by the green-fluorescent hairs, the ectothrix nature of the spores on the infected hair, and specifically by the characteristic colonies on culture.

In children, the crusted lesions of impetigo of the scalp may simulate inflammatory Trichophyton tonsurans infection, but the thick crust and oozing base, the absence of white plugs under the Wood light, and laboratory confirmation of fungous disease should decide the issue. Typical impetiginous lesions are frequently also found on the face or ears and there is usually quick response to various germicidal and antibiotic preparations. However, impetigo may lead to temporary alopecia much like

* The crateriforme group includes the following four species: Trichophyton tonsurans (T. crateriforme); T. epilans (T. cerebriforme); T. Sabouraudi (T. acuminatum); and T. sulfureum.

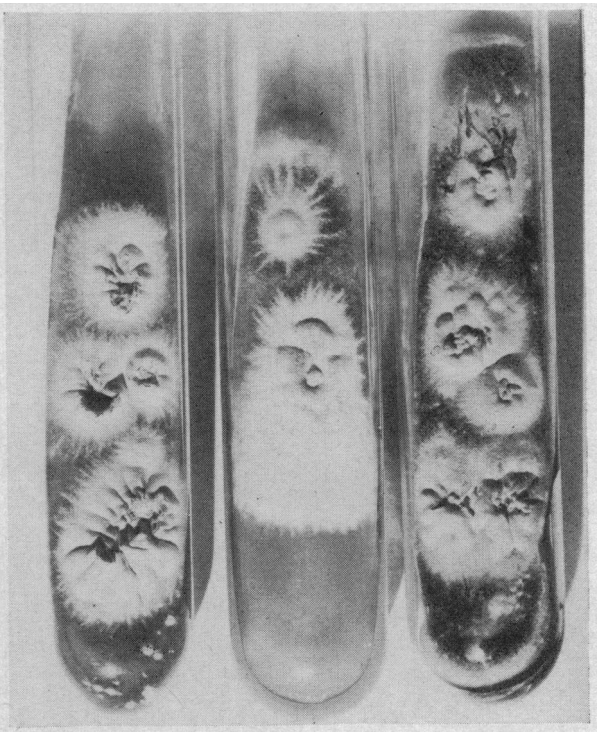

Fig. 5.—Crateriform colonies of Trichophyton tonsurans.

that which occurs in involuted inflammatory Trichophyton tonsurans infection (bald ringworm of the English), and unless active lesions are present, it may be impossible to arrive at a definitive diagnosis. Similarly, the plaques of "bald ringworm" often bear a close resemblance to alopecia areata, although the latter condition is not preceded by inflammation.

Other diseases of the scalp that are characterized by scaling patches, such as seborrheic dermatitis or psoriasis, ordinarily do not cause loss of hair.

The authors have observed a few patients with trichotillomania and trichokryptomania who had bald spots on the scalp similar to those caused by Trichophyton tonsurans infections. However, in those instances there was no evidence of scaling or inflammation, and the patients, when questioned, readily admitted the cause.

As the severe inflammatory reaction (kerion) may be mistaken for a carbuncle, it is well to examine hairs at the site of such a lesion under a Wood light lest incision be made unnecessarily.

CLINICAL MATERIAL

During the two and one-half year period from July 1947 to January 1950 the diagnosis of tinea capitis, based on the cultural isolation of a specific pathogenic fungus, was made in 484 cases. The relative frequency of infection with various organisms is shown in Table 1. In 57 cases the organism was Trichophyton tonsurans. The patients were from 4 to 15 years of age. Fifty were boys, seven girls. All were Negroes, but no particular significance can be attached to this inasmuch as the vast majority of the patients observed at the clinic are of that race.

TABLE 1.—*Incidence of various organisms in 484 cases of tinea capitis.*

Organism	No. of cases	Per cent
Microsporum audouini	339	70.04
Microsporum lanosum	86	17.77
Microsporum fulvum	2	.41
Trichophyton tonsurans	57	11.78
Total	484	100.00

From a prognostic viewpoint, classification of the disease into inflammatory and non-inflammatory types was advantageous. Twenty-seven children (47 per cent) had lesions of the dry, scaly, non-inflammatory type. The inflammatory type was further divided into the superficial variety and kerion. The superficial variety was characterized by follicular papules and pustules, edema, oozing, and crusting. This kind of reaction frequently subsided with or without treatment. It was observed many times, however that slightly inflamed areas were converted into kerion by treatment with various antifungal ointments or by home treatment with iodine or other irritant preparations. In other cases, kerion apparently arose spontaneously. Kerion occurred in 17 patients (30 per cent), the superficial inflammatory variety of the disease in 13 (23 per cent). Thus, in the majority of the patients (53 per cent) some degree of inflammatory reaction was present. Of the 57 patients, 49 were sufficiently cooperative to permit of some evaluation of the course of the disease and response to therapy. Each of the 49 patients was observed at the clinic for a period of at least two months and the majority for a much longer time.

TREATMENT AND RESULTS

Treatment consisted of daily applications, at home, of various antifungal preparations including salicylanilide ointment, Sopronol® ointment, sulphur ointment and a few newly developed antifungal preparations furnished by pharmaceutical firms for evaluation. Directions were given to shampoo the child's head every evening and then to rub the medication vigorously into each patch. The antifungal preparation was also applied once or twice during the day. Clipping or shaving of the hair from the scalp was requested at intervals of one to two weeks. This was extremely important from the standpoint of determination of cure, for with regrowth of hair it became increasingly more difficult to visualize the white plugs and short hairs of the infected areas. Single or small groups of infected follicles may very readily be overlooked and serve as a nidus for reinfection. Moreover, follicular accumulations due to grease, soap, medicament, or keratin, may be mistaken for infected hair follicles in examination with a Wood light. For this reason, careful shampooing and rinsing of the hair before each visit to the clinic was insisted upon. Results with detergent shampoos were better than those obtained with soaps. A declaration of cure was made with reservation and only after repeated Wood light examinations and mycologic studies of any suspect follicular material. Determination of cure in Trichophyton tonsurans infection is much more difficult than is the case with Microsporum infection. In Wood light examination the white plugs and short white hairs which characterize Trichophyton tonsurans ringworm are not as easily identified as are the brilliant green hairs of microsporosis.

Results in 49 cases in which the patients were under treatment for at least two months are shown in Table 2. There was no untreated control group.

As it was not known how well directions for treatment at home were followed, and as there were other variable factors, the response to various medications could not be satisfactorily evaluated. However, certain impressions were gathered, and it was possible to derive some information of a general nature. The presence of inflammation is a good prognostic sign: The deeper the reaction, the better the result. Significance can be attached to the observation that the incidence of cure was much higher in those patients who had inflammation than in those who had lesions of the dry, non-inflamed type. Twelve patients with kerion were free of infection after an average treatment period of 5.7 months, whereas for the ten patients with lesions of the dry type who were cured, the average treatment period was 11.6 months. It was noted that the dry, non-inflammatory type of infection was usually resistant to all forms of local therapy. A number of patients with this variety of the disease still had infection two years after treatment was started. Whether this infection tends to spontaneous cure at puberty, as does tinea capitis due to Microsporum audouini, cannot definitely be answered at this time. There were no adults in the series. However, at dermatological meetings in Los Angeles a number of cases of adults with tinea capitis caused by Trichophyton tonsurans have been presented. It is the authors' impression that many of the children with infection of the resistant type may carry the disease into adult life unless inflammatory reaction develops. Continued observation of the uncured members of this group may confirm or alter this impression.

Roentgen ray epilation was used in a few of the patients with successful results. This undoubtedly is the treatment of choice for the non-inflammatory resistant variety of the disease.

Treatment of kerion consisted of application of hot magnesium sulphate compresses and 5 per cent ammoniated mercury ointment. This usually checked the severe inflammatory process. In some cases of multiple kerion, procaine penicillin was given parenterally with prompt response.

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TABLE 2.—*Results of Treatment*

Kind of lesion	No. Patients	Cured	Not Cured	Average Period of treatment (months)	Range of Period of treatment (months)
Dry	23	10	13	11.6	4 to 22
Inflammatory:					
Superficial	10	5	5	5.4	4 to 8
Kerion	16	12	4	5.7	3 to 12

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The Medical Care Dollar

Americans spent $8,500,000,000 on medical care in 1950. . . . Bureau of Economic Research of A.M.A. analyzes U.S. Commerce Dept. study . . . this is 4.4 per cent of total spent for all consumers' goods and services . . . physicians received $2.4 billion, hospitals $2.0 billion, drugs and sundries $1.4 billion, dentistry $1.0 billion and other medical care $1.7 billion . . . from 1930 to 1950, physicians' share of medical care dollars fell 12 per cent . . . hospitals' share increased 66 per cent, dentists' dropped 26 per cent, drugs' declined 12 per cent and "others" rose 5 per cent.

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