

THE ROLE OF ANIMAL-TYPE DERMATOPHYTES IN HUMAN RINGWORM

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A feature of dermatology in recent years has been the increased incidence of fungous diseases. Attention has been drawn to the fact that ringworm infections in particular are seriously increasing (Ingram, 1944) and that ringworm of the scalp, which had become a comparatively rare disease, is again threatening to attain epidemic proportions.

Comment has never been lacking on the association of ringworm in man with animal contacts and on the finding of "animal-type" fungi in human lesions. Possibly because it is not always easy to trace the infection from animal to man, this association has been presented in the light of an uncommon occurrence. It is our belief that the importance of the animal source of infection in human ringworm has been insufficiently stressed in this country, and that animal infections occur far more often than is commonly supposed. The mycological findings in ringworm specimens submitted to cultural methods of investigation show a high proportion of fungi hitherto considered unusual in human lesions, especially in ringworm of the scalp, and suggest either that we are witnessing an increase in the incidence of ringworm in man caused by dermatophytes usually parasitic on the lower animals, or that infection by these types of dermatophytes has in the past been incompletely assessed.

In a consideration of the epidemiology of ringworm a distinction is drawn between *tinea circinata* and *tinea tonsurans*. A survey of the literature shows that, in the former, animal sources of infection have been recognized from time to time; but in the case of *tinea tonsurans* the connexion appears not to have warranted any detailed consideration. Kinnear (1931) reported that the occurrence of infection of the scalp with microspora other than *M. audouini*, was very rare in this country. Ashton (1932), investigating the frequency of ringworm in cattle, concluded, after interviewing nearly 400 insurance practitioners, that ringworm derived from animals was not uncommon in certain districts, but chose particularly the glabrous skin rather than the scalp. More recent English publications (Roxburgh, 1944; Shanks, 1944) advocate treatment of *tinea tonsurans* only by x-ray epilation, and, except for suppurative cases, make no mention of the conservative method, which is permissible where the causative organism is an animal type.

The prevalence of the different types of pathogenic fungi is known to vary from country to country and, indeed, from locality to locality. Sabouraud was at pains to emphasize the frequency of animal-type infections in ringworm subjects in France. In the United States the importance of animal types of fungi has for long been realized. The practical significance of these epidemiological considerations was recognized by Lewis and Hopper (1937), who correlated and confirmed the findings of earlier American workers (Bloch, Jadassohn, Miescher, etc.). These had suggested that scalp infections caused by microspora pathogenic to animals are curable by topical methods alone. The topographical variability in the United States is well described by Wise and Sulzberger (1938). They point out that when one considers that in the west and south-west States almost all mycotic scalp infections are due to the "animal-parasite" fungus *M. lanosum*, while children in the cities of the eastern seaboard are mainly affected by *M. audouini*, the human form, it becomes at once comprehensible that the results of various types of prophylaxis, therapy, etc., must be completely different in different parts of the United States.

The role of *M. felineum* as a cause of ringworm in children has been investigated in Canada by Davidson and Gregory (1933). In a study of ringworm in Winnipeg they isolated species of microsporum from 75 children, 43 being *M. audouini*, and 32 *M. felineum*. However, as 19 of the *M. audouini* isolations were from a single school outbreak, the authors considered that a fairer impression of the relative importance of the two species, in the area, would be given by a quotation of the number of outbreaks caused by each. These were: *M. audouini* 14, and *M. felineum* 24.

To attempt to estimate the incidence of animal-type ringworm in Great Britain is no easy matter, and one is forced to the conclusion that not enough evidence is obtainable from published records to support any dogmatic statement as to the relative frequency of the human and animal types. Sabouraud (1910) stated that the earlier English observers had not controlled their microscopical examinations by cultures. He asseverated that animal microspora were not rare in England, it being probable that the cases of *tinea circinata* ascribed by Adamson and others to *M. audouini* were in fact caused by animal dermatophytes.

Fox and Blaxall (1896a, 1896b) were the first workers to demonstrate the transmission of cat ringworm to man. They recovered *M. felineum* from 14 cases of ringworm, and were able to trace the infection to 11 separate sources.

Generally speaking, little has been done by culture tests to determine the types of ringworm fungi in Britain, apart from some local investigations. Tate and Hare (1928) examined specimens from L.C.C. schools and found *M. audouini* to predominate. Smith (1944) refers to the oft-quoted figure of 90% as representing the incidence of *M. audouini* in cases of *tinea tonsurans*. We have reason to believe, however, that infection by animal types of microspora is now much more frequent than this figure suggests. Duncan (1945) isolated 265 cultures of dermatophytes from unselected cases of human ringworm in various parts of England and Wales, but chiefly in the southern counties, and found that 58% were types usually parasitic on the lower animals. The genus *Microsporum* was represented by 211 cultures, of which 122 (57.8%) were of animal types (*M. felineum*, 74; *M. lanosum*, 48) and 89 of the human type (*M. audouini*).

Animal Contagion

Most of the common domestic animals have at different times been suspected of imparting ringworm to man. With animals, as with man, it is the young that are most susceptible to infection. Calves have probably been most often implicated, especially on the European continent, and it was in relation to them that the transmission of ringworm from animal to man was first described. In 1840, contemporaneously with an epizootic of ringworm among cattle, almost the entire population of the Swiss village of Andelfingen was known to have ringworm. A smaller outbreak was recorded in 1925 at the cattle-testing station at Pirbright, in this country. Despite specific precautions, five attendants were infected from diseased cattle. Ashton (1932) reached the following conclusions, *inter alia*, regarding ringworm in man.

1. It is the trichophyta rather than the microspora that are commonly communicated to man from cattle.
2. Young stock animals are chiefly involved.
3. Dogs and horses are also susceptible, goats and cats more rarely.
4. Direct contact with the animals or with posts, etc., they have rubbed against is the usual method of transmission.
5. The disease is often limited to the arms and forearms.
6. The prognosis is good and spontaneous cure may occur.

At the present time, while sporadic cases from calves are being constantly encountered, cattle ringworm does not present a problem of urban districts or a source of institutional outbreaks.

Grooms, farriers, and others were formerly often infected from horses. As in the case of cattle ringworm, in which adult males are the victims of contagion, *tinea barbae* is a typical manifestation of the affection. More modern methods of locomotion have rendered the horse an unimportant focus of ringworm infection nowadays, but it used to be otherwise. Tilbury Fox (1871) described an outbreak of ringworm involving seven men, who had received their infection from a pony, but even

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in those days this plurality of victims was considered exceptional. Bunch (1901) was able to demonstrate cultural proof of connexion between two cases of human ringworm and their equine sources.

A cat was proved to be responsible for the biggest recorded "epidemic" produced by one animal. Roberts (1909) described how a kitten brought from Egypt communicated ringworm to 13 persons and another cat directly, and to a child and a dog indirectly. It was found possible to take specimens for culture from all those infected, and the same species of microsporum was isolated in each case. There is no dearth of evidence incriminating the cat in smaller outbreaks and sporadic cases. It is interesting to note how frequently a stray kitten has been taken into a household just before the occurrence of a case of ringworm in that house.

Whereas no textbook omits to refer to canine hosts, the friend of man seems to have been neglected in attempts to provide direct cultural connexion with human ringworm. Sabouraud *et al.* (1908), in their work identifying *M. lanosum* with *M. canis* (Bodin), noted that a particular character of this microsporum is that it often gives rise to family epidemics. They instance an outbreak in a family of six persons, all with ringworm lesions. *M. lanosum* was recovered from five of the cases; the sixth was not seen. As to the source of the epidemic, they stated that a dog was accused, without proof, of this family outbreak. More recently in France, Stevenin (1937) has recorded three cases occurring in veterinary students; *M. lanosum* was found on culture in each case, but it was not possible to trace the infection to a particular animal. In England, Bunch (1901) included a terrier in his series, showing that the dog was infected with the same organism as he recovered from a case of kerion.

Our own experience in this respect is considered worthy of record. We have recently encountered an epidemic in which an adult and four children, directly, and four children and a cat, indirectly, were infected from a puppy (Table I). Conclusive

TABLE I.—The "Island" Epidemic

Case No.	Age	Contact	Condition	Lesions
1	8	Puppy	(a) <i>Tinea circinata</i>	(a) Twelve scattered circular scaly patches, about 1 cm. in diameter, on face. Multiple similar patches on chest, with uniform papulation. Limbs liberally covered with small papular and pustular microsporides.
			(b) <i>Tinea tonsurans</i> (developed subsequently)	(b) Patch, 1.5 cm. in diameter, in occipital region, almost devoid of hair and showing slight scaling
2	13	"	<i>Tinea circinata</i>	Multiple minor healing lesions on face, neck, arms, and left thigh. On the right thigh a large fresh circular patch, papular and mildly erythematous
3	10	"	"	Five discrete circular lesions on face. Diffuse scaling on neck. Multiple scattered papular microsporides on limbs. Large solitary patch on front of chest
4	10	"	"	Eight discrete circular lesions, ½ cm. in diameter, on face, neck, chest, and arms
5	12	Case 2	"	Solitary raised circular patch with red papular edge and healed scaly centre on inner side of right upper arm
6	6	?	<i>Tinea tonsurans</i>	Circular patch, almost denuded of hair and covered with thick scales, in occipital region
7	11	Case 3	<i>Tinea circinata</i>	Red scaly lesion on right arm, 2.5 cm. in diameter, and with slight peripheral vesiculation
8	10	"	"	One circular scaly lesion, 2 cm. in diameter, on thigh. Small peripheral papules

surgeon. Cases 1, 2, and 3 (Table I) were the children of the one adult concerned. All the patients lived in three neighbouring streets, in a part of the town which is known as the "Island" but which is, in fact, a peninsula separated from the main town by a causeway some 200 yards long. They all attended the same school, four of the girls being in one class. The puppy had been recently acquired, and was observed to be in what was described as a "mangy" condition when bought. No child had any skin lesions before the purchase of the animal, and we have not been able to trace any case of ringworm on the Island for at least 12 months previously. The puppy was a mongrel of uncertain origin and age. Inspection revealed gross involvement of its skin, the trunk being almost devoid of fur and the limbs and head only sparsely covered. The denuded areas were layered with an abundance of large flaky scales, which were easily detachable.

The causative organism in all these cases was found to be *M. lanosum*. In order to trace the subsequent course of the outbreak and to investigate the possibility of another focus of infection, all cases of suspected ringworm occurring in the immediate locality since, and also further afield in the area, have been examined and specimens taken for culture. It is a fact that, in 21 positive cultures over a period of eight months, *M. lanosum* has not once been found, though *M. felineum* has been frequent.

The subsequent unselected cases, 45 in all, yielded interesting information when specimens from them were submitted to culture. Table II shows the results in the 21 positive cultures,

TABLE II

Case No.	Age	Condition	Contact	Organism	Type
9	8	<i>Tinea circinata</i>	—	<i>M. felineum</i>	Animal
10	11	"	—	<i>T. tonsurans</i>	"
11	9	<i>Tinea tonsurans</i>	—	<i>M. audouini</i>	Human
12	8	"	—	"	"
13	6	<i>Tinea circinata</i>	Calf	<i>T. asteroides</i>	Animal
14	7	<i>Tinea tonsurans</i>	—	<i>M. felineum</i>	"
15	8	<i>Tinea tonsurans</i> and <i>circinata</i>	Kitten	"	"
16	10	<i>Tinea circinata</i>	Kitten (Case 15)	No specimen taken	"
17	7	"	—	<i>M. felineum</i>	"
18	3	<i>Tinea tonsurans</i>	Case 17	Culture negative	"
(brother of 17)					
19	8	"	Kitten	<i>M. felineum</i>	"
20	35	<i>Tinea circinata</i>	Calf	<i>T. discoides</i>	"
21	13	<i>Tinea tonsurans</i>	—	<i>T. asteroides</i>	"
22	10	<i>Tinea circinata</i>	Kitten	"	"
23	5	"	Brother	"	"
24	1½	"	—	"	"
25	12	"	—	"	"
26	5	<i>Tinea tonsurans</i>	Case 11	<i>M. audouini</i>	Human
27	9	"	Case 26	"	"
28	13	<i>Tinea circinata</i>	—	<i>T. asteroides</i>	Animal
29	3	"	Kitten	"	"
30	12	"	—	"	"
31	9	"	—	"	"
(sister of 30)					

and otherwise includes only the two instances of simultaneously affected siblings, in one of which no specimen was obtained for culture and the other giving a negative finding. The large preponderance of animal-type dermatophytes in all these sporadic cases is at once apparent.

Opportunities of examining the animal suspected of being the source of the various infections, by means of Wood's light, etc., have not often presented themselves, and obviously the majority of patients are able to describe some household pet. But we regard the frequent association of kittens and other young animals with cases of ringworm as more than coincidental. In Cases 15 and 16, for instance, the destruction of their kitten because of a "diseased" coat, following the onset of these two cases, is unlikely to be fortuitous; and in Case 20 the patient, a slaughterman, explained that a few days previously he had dressed a calf's carcass, the coat of which had "alopecia." A colleague of his was said by him to be similarly affected.

Specimens from 22 patients gave negative results. Of these, 12 were on clinical examination considered to be probably ringworm. One girl—clinically our most certain case of ringworm—possessed two Persian kittens, which are reputed to be particu-

cultural evidence as to the essential unity of the outbreak was forthcoming in the cases of the eight children and the dog. Hull (1941) has averred that most reported cases of transmission between man and animals are open to criticism, as they are based on slim circumstantial evidence. Accordingly, we have made every effort to obtain direct evidence, where possible. The affected adult was unwilling to submit to examination, and the cat, domiciled next door, was destroyed after a diagnosis of ringworm had been made independently by a veterinary

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larly susceptible to ringworm. Another possessed a recently acquired kitten, and a third a puppy.

There remained 10 cases, which had specimens cultured on the off-chance of their yielding a ringworm fungus, but which were probably not ringworm. Only one of these subjects possessed a kitten. Thus, quite apart from the Island cases, close contact with young animals was found in 12 out of 35 cases of proved or probable ringworm. No pretence is made that statistical significance can be read into such small numbers, but they do tend to confirm the suggested infectivity of young animals, already referred to.

Two other points must be borne in mind when assessing the importance of animal contagion. On the one hand, older animals may play some part in the transmission of infection. Sabouraud *et al.* (1908) found that the average age of 15 dogs with ringworm was 23 months. On the other hand, animal-type fungi can be transferred between human beings, but opinions differ as to the proportions thus communicated. Lewis and Hopper (1937) point to this facility of transmission from man to man as a method of distinguishing between animal and human types of infection. Thus the ease with which human types pass between human beings, and animal types between animals, is in contrast with the smaller risk of contagion from man to animal and animal to man. This fact is borne out in our Island series. The four primary cases were all grossly infected, the four secondary cases showed only solitary lesions, and we have been able to trace no transmission from these to tertiary cases. Obviously the profusion of the pathogen accounts for the severity of the directly infected persons. The areas of their bodies affected were chiefly the chin, the neck, the upper part of the chest, and the front of the forearms—i.e., the areas of contact with the puppy when they nursed it, as apparently was often the case.

Nature of Lesions

As regards the glabrous skin, the wide variability of the lesions has often been described. As long ago as 1871 Tilbury Fox pointed out that ringworm of the surface varies considerably in aspect, from a mere desquamating erythema to a pustulating surface resembling, and apt to be mistaken for, eczema, there being many transitional herpetic forms. In his pony cases the severity of the lesions was considered to depend on the profusion of the fungus implanted on the skin, and our puppy cases correspond with this. Despite the variability in clinical appearances, the typical ringworm patch—circular, faintly erythematous, with central scaling and peripheral papulation—was most frequently encountered.

Infection with animal-type fungus is considered to produce more inflammatory lesions on the glabrous skin, to be more resistant to treatment, and, as already mentioned, to be less contagious. No great difficulty is experienced in clearing up the smaller solitary lesion of either animal or human type, but the severer infections, in which microsporides are present, may prove refractory. The time taken to cure the four primary puppy cases varied between five and ten weeks.

The clinical appearances in ringworm of the scalp often make it possible to distinguish between animal and human types of infection. The classical description of tinea tonsurans met with in the various textbooks applies particularly to those cases in which *M. audouini* is the pathogen. The typical patch shows as a greyish and scaly area, with hairs broken off to about one-eighth of an inch. These stumps have lost their elasticity and, being bent in different directions, have an appearance described as "stubbled corn." Erythema is not marked, there is rarely swelling, and oedema and pustulation are absent. The patch may increase in size to involve almost the whole of the scalp, but will be found to have a clear-cut circumscribed growing edge.

Generally the animal types of infection produce an inflammatory appearance. The skin is reddened, often swollen, almost devoid of hair, and occasionally surmounted by pustules, without necessarily reaching the grossly suppurative condition known as kerion. The few remaining hairs are easily removed with forceps. Exceptions to this general description are met with, and in the two *M. lanosum* cases (Nos. 1 and 6) erythema was entirely absent. Yet these two children, whose parents refused treatment, went on to achieve a spontaneous cure.

Multiple patches have been commoner than single ones in these animal-type cases. The larger patches sometimes evidence pustulation, while the smaller lesions in the same case may be erythematous only.

Treatment

The treatment of tinea circinata merits no special description. The number of fungicidal preparations is legion and most of them are effective. We have found, for routine treatment, that Whitfield's ointment is quite efficacious, and we have not had recourse to the more elaborate proprietary remedies.

It is in cases of tinea tonsurans, however, that the importance of distinguishing between human and animal types finds its greatest application. In the former group epilation by means of x rays is the method of treatment that holds pride of place, and its value is indisputable. Many consider that thallium acetate should no longer play a part in the treatment of ringworm of the scalp, and the Ministry of Education does not sanction its use. There are also objections, however, to the use of x rays, and the following may be mentioned.

1. There may be failure of re-growth. Shanks (1944) reports that, with modern apparatus and accurate dose calibration, these accidents are now rare. With less skilled workers the number of cases of permanent alopecia rises.
2. A period of some five to six months is required before a full growth of hair is obtained, and the more sensitive children, especially girls, object to returning to school at the end of one month after treatment, which is the minimum time in which they may be allowed to do so.
3. Apparatus is not everywhere available, and, particularly under present conditions, treatment is unobtainable in some districts.
4. X rays are unsuitable for very young children.

The group of scalp infections attributable to an animal dermatophyte differs from the human type in being amenable to treatment by topical measures alone. In this country it had been usual to restrict these conservative measures to suppurative cases. Of the nine cases of animal-type scalp ringworm (Table III), four at some stage showed evidence of slight pustulation,

TABLE III.—*Tinea Tonsurans* Cases

Case No.	Organism	Mode of Cure
1	<i>M. lanosum</i>	Spontaneous
6	"	"
11	<i>M. audouini</i>	X-ray epilation
12	"	"
14	<i>M. felineum</i>	Conservative
15	"	"
17	"	"
18	Probably <i>M. felineum</i>	"
19	<i>M. felineum</i>	"
21	<i>T. asteroides</i>	"
26	<i>M. audouini</i>	X-ray epilation
27	"	" "

and five were non-suppurative. As previously mentioned, two of these underwent spontaneous cure in eight and thirteen weeks respectively. The remainder received topical treatment and were cured in periods varying from four to eight weeks, but it was not considered that these times were minimal. Cure was assessed by negative response to Wood's light, negative result to direct microscopy, and, in one doubtful case, negative culture, all treatment having been discontinued for seven days. On the affected patches new hair grows slowly and does not keep pace with the re-growth of the rest of the scalp.

The routine treatment adopted was similar to that described by Sutton and Sutton (1941) as follows:

1. Close clipping of the hair over the whole scalp.
2. Daily shampoo with ordinary soap.
3. Epilation of hairs from the affected patches and from a narrow margin around the patches, the hairs extracted being carefully burned.
4. Application daily of an ointment containing 6% precipitated sulphur and 4% salicylic acid. This may be rubbed into the lesions so long as no untoward reaction is observed.
5. The wearing of a clean linen cap, which should be renewed daily.

The willingness of the parents to co-operate in this somewhat elaborate toilet had previously been doubted, but with the

exception of the two cases in which they refused any treatment, their response was surprising and gratifying. Their aim was to get the child back to school in the shortest time.

Discussion

It is apparent that the type of infection has considerable prognostic significance, and that the lesions produced by dermatophytes pathogenic to animals are those likely to be cured spontaneously or without great difficulty. It has been indicated that, of the human type of fungi, *M. audouini* is very resistant to treatment and is a common offender in this country, but it must be noted that Livingood and Pillsbury (1941) have shown that even *M. audouini* infections have occasionally been known to heal spontaneously, sometimes before puberty, if left long enough. Much less common, but even more resistant to treatment, are the endothrix trichophyta (e.g., *T. tonsurans*, *T. sabouraudi*). The ectothrix trichophyta (e.g., *T. asteroides*), representing animal infection, while producing more violent local inflammatory reaction, are easily amenable to treatment.

In the United States, Lewis and Hopper (1943) go a stage further in their adherence to conservative methods of treatment. They divide their scalp ringworms into resistant and non-resistant groups of infection. The non-resistant cases are those which respond to local therapeutic measures, and include not only those produced by animal dermatophytes but also those human-type infections which produce, among other symptoms, markedly inflammatory reactions. In the resistant group such simple measures are unlikely to succeed. Nevertheless even here manual epilation under filtered ultra-violet rays, followed by the application of adhesive plaster, has, in their experience, been found adequate treatment for some small patches of tinea tonsurans.

From the preventive aspect attention should be paid to animals which are likely to be infected with ringworm. It may be difficult to get a patient to part with his pet (the Island puppy still lives), but he can be induced to consult a veterinary surgeon, and treatment of the animal instituted. Wooldridge (1934), advocating the use of Wood's light by veterinary surgeons, makes it clear that a careful search is indicated before absolving an animal from a charge of ringworm. He points out that in the cat there may be no loss of hair, and that the small size and general hidden character of the lesion, coupled with the fact that there is little irritation, may result in its being easily overlooked even on close inspection. It would be advantageous if the introduction of kittens, particularly stray ones, into a community of children could be preceded by such an examination. As a further precaution, animals belonging to households containing ringworm should not be sold or allowed their freedom.

Finally, the advantage of cultural methods in diagnosis, which provide the only means of identifying the species of the infecting fungus, must be obvious to all, and they should be used whenever practicable. In the borderline cases, where there is no clinical indication as to the type of infection, it is submitted that the patient should be given the benefit of the doubt and only conservative treatment undertaken. Culture on a larger scale will eventually give valuable information as to the organism predominating in a particular area, and knowledge of this will be a further pointer in diagnosing between animal and human types of infection.

Summary

The position of ringworm infection with animal-type dermatophytes in this country is reviewed.

Well-authenticated cases of the transmission of ringworm from animal to man are described.

An account is given of a recent particular outbreak in which five persons directly and four persons indirectly were infected from a puppy, the association being proved by cultural investigation.

Some 20 subsequent cultures, taken from patients in the same area, are discussed and the type of organism given.

Clinical findings are described.

Treatment of tinea tonsurans is discussed, and stress is laid on the importance and practicability of treating by conservative methods scalp ringworm produced by animal-type fungi.

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NERVE INJURIES IN CHILDREN

BY

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Injuries of the peripheral nerves in children are fortunately rare, but when they do occur they present certain peculiarities so unexpected that it appears worth while to describe two recent cases. Both were injuries of the deep branch of the ulnar nerve due to deep penetrating wounds by glass fragments, in both suture was undertaken after healing of the original wound and the full establishment of degeneration and paralysis, and in both recovery was rapid and complete.

Case I

Mary S., aged 10, was referred to me by Dr. Riddoch with the history that six months previously she had fallen while holding a glass vase. The glass broke and penetrated the palm of the right hand, just below and lateral to the pisiform bone. A small healed scar showed the point of entry. Sensation was normal, but there was complete paralysis of all the muscles of the hand supplied by the deep branch of the ulnar nerve; Froment's sign was present.

Through a curved incision, lateral and distal to the pisiform, the deep structures of the wrist and palm were exposed. The main trunk of the ulnar was first identified and the cutaneous branch seen to be intact. On following the deep branch it was found to be completely divided, ending in a small end-bulb. The distal portion, also with a small bulb, was found with ease, and after removal of the bulbs suture was effected with very fine catgut. Healing was normal, and ten months later recovery of all the small muscles appeared to be complete and the function of the hand normal. At the time of operation the great size of the nerves and the facility of suture were remarked.

Case II

John M., aged 6, was cut by glass in an air raid, a wide deep wound extending across the inner border of the right hand just below the wrist. A large deep scar remained. Sensation was lost in the ulnar area of the hand and there was paralysis of all the small muscles supplied by the ulnar nerve; Froment's sign was present.

It seemed doubtful if in such a small hand suture could be effected, but on exposing the tissues in front of the wrist the ulnar nerve was found to be of almost adult size and quite out of proportion to the other structures. The deep and superficial branches were followed with ease and both were found to be completely divided, ending in bulbs. The distal portions were found without difficulty and suture of each was effected in the usual manner. A year later there was complete recovery both of sensation and of movement, and the function of the hand appeared to be perfectly normal.

Commentary

These two cases give rise to several curious observations. It would appear that the peripheral nerves in a child are out of all proportion to the other structures, and indeed approach adult dimensions. On reflection it is what one would expect on