INTERNATIONAL JOURNAL OF LEPROSY

VOLUME 17, NUMBERS 1 & 2 JANUARY-JUNE, 1949

THICKENING OF SUPERFICIAL NERVES AS A DIAGNOSTIC SIGN IN LEPROSY [1]

JOHN R. MURDOCK, M. D.
Medical Director, U. S. Public Health Service
Assistant Director, Pan American Sanitary Bureau
Washington, D. C.

The fact that the superficial nerves are very commonly the site of pathology in leprosy, and that contrary to the common belief that the affection is confined to two or three particular nerves—such as the great auriculars, the ulnars, and the external peroneals—many of them may be involved, was impressed on me during three years and more of intensive study of the disease at the Kalihi Hospital, Honolulu, Territory of Hawaii.[2] An individual case may show involvement of many nerves, while another case may have but one nerve involved—and one so located as to be easily overlooked. It is important, therefore, that the examiner should make a thorough examination of all superficial nerves in every suspected case. Although nerve involvement of some degree may be present in any stage of the disease, it is intended in this paper to stress the almost constant presence

[1] This study was made during the period 1929-1933, when the author was a Passed Assistant Surgeon, U.S.P.H.S. The paper as prepared at the time was not accepted for publication because of inability, on the part of the referee to whom it was submitted, to confirm the reported findings among the advanced leprosy patients at the Carville hospital in Louisiana. It has now been revised somewhat, mainly with respect to the literature, and is offered to call attention to a condition which is not—as would seem to be the general assumption—without significance outside of India. Published with permission of the Surgeon General, U. S. Public Health Service.

[2] It is to be understood that the Kalihi Hospital was—as it still is—the receiving station where most of the newly found cases are taken care of for varying periods before being transferred to the Kalaupapa Settlement on Molokai Island. The patients may be detained there for months or even years, according to circumstances, but in any event long enough for thorough study.

of this sign in the earlier stages. When enlarged superficial nerves are encountered in a case suspected of being leprosy, the finding should be considered as strong presumptive evidence of the disease.

At the time this work was done the importance of the finding of superficial nerve involvement, especially in early cases in which other diagnostic signs are concealed and obscure, had never been stressed. A review of the literature on the subject brought to light only passing mention of the matter. Thin, in 1891 (20), merely mentioned that the superficial nerves are occasionally involved. Laehr (5), gave a table of forty cases in which he had found nerve thickening. Monrad-Krohn, in 1923 (8), had devoted but a few paragraphs to the subject of thickened superficial nerves and Wayson, in 1929 (26), had condensed the subject into three short paragraphs.

Beginning about that time, however, the matter was given considerable attention in Muir's clinic in Calcutta. At first his interest was concentrated on the involvement of the nerve branches which supply affected skin areas (i.e., macules); for example, in writing of early diagnosis in 1930 (10) he mentioned only that condition. Later Muir and Chatterji (11, 12) studied the histology of the affected nerves in the cutis and subcutis, undertaking to demonstrate that "the early leprous nerve lesions, common in India and other countries," are caused by extension of the granulomatous condition of the cutis. It is obvious that in this study they were dealing with the tuberculoid form of lesion exclusively.

Shortly afterwards Chatterji (1) wrote on the clinical features of superficial nerve involvement in relation to skin lesions, tabulating the frequencies with which the various individual ones—no less than 22 of them being listed—were found thickened in 1,024 cases, those cases being the ones (33.3%) which were found to have enlarged nerves out of 3,079 examined. He emphasized the importance of the condition in relation to diagnosis, and also to prognosis and treatment. Subsequently Chatterji (3) expanded on the subject, with diagrams showing the locations of the nerves of the head and neck, the upper extremities, and the lower extremities which may be affected.[3] With all this, however, in describing the early manifestations of leprosy as seen in an outpatient clinic (2) he listed nerve thickening among the "sundry symptoms." Wayson (25) mentioned thickening as one of the manifestations of nerve involvement seen in children, but again he laid no particular stress on it.

[3] In an introductory article to a series of studies of skin lesions in neural leprosy, Wade (23) pointed out that, whereas the examination for enlarged nerves is usually confined to the main peripheral trunks, in the Calcutta clinic the superficial cutaneous nerves are carefully examined in all neural cases; and a diagram used there in locating the principal nerves concerned was reproduced. It was pointed out that a palpable nerve need not necessarily be an abnormally large one, and that at times enlargement may not be diagnosed unless the corresponding nerve on the other side is definitely smaller.

Having severally gained some experience in Calcutta in the search for enlarged cutaneous nerves, Wade, de Simon and Fernando (24) tabulated their findings in the 53 neural cases which they had under special study in Colombo. Notable enlargement was less frequent than in Calcutta, it was concluded, though some degree of it was not infrequent. "This matter of nerve enlargement," they suggested, "deserves careful investigation in different parts of the world." Later, with respect to cases studied at Cebu, Rodriguez and Wade (15) stated that in the Philippines, unlike Calcutta, "important thickening" of the cutaneous nerves in relation to skin lesions is uncommon. The inference follows that there may be "racial" or at least regional variations in this matter.

THE CLINICAL EXAMINATION FOR THICKENED NERVES

In the initial examinations of my first fifty or so cases, I followed the usual practice of inspecting and palpating only the great auricular, ulnar and, at times, superficial peroneal nerves. This procedure was changed when, during a routine examination, a recently admitted patient was discovered to have no less than 30 thickened superficial nerve trunks. Many of them were so prominent that good photographic reproductions could be secured. This patient was studied intensively on many occasions, to impress the examiner with the location of the individual nerves, the quickest and easiest method of detecting abnormalities, and the best manner of demonstrating them to others.

Each newly admitted patient, thereafter, was studied carefully for thickened nerves, and soon other cases were found which presented similar pictures although with less extensive involvement. With practice a routine method of examination was evolved which required minimal time to perform. Patients already in the hospital were reexamined, and it was soon learned that many who had previously been considered negative had superficial nerve involvements.

The intelligent cooperation of the patient is of great assistance in all examinations for superficial nerves. He can aid materially in differentiation between nerves, tendons and blood vessels. It is good practice to acquaint him with the sensation of nerve pain by pressure on the ulnar before searching for less frequently involved nerves.

Nerves of the head and neck.—In a good light, preferably coming from above and striking the patient tangentially, the supraorbital branch of the frontal nerve, if thickened, may be seen in its position in the forehead extending upward and laterally from the middle third of the eyebrow. This nerve is palpated by gently moving the tips of the fingers laterally across the brow from the midline; fingers parallel to the direction in which the nerve runs. The supratrochlear nerve, located nearer the midline, may be found in a similar manner.

One of the nerves most difficult to see is the temporofacial branch of

the facial, but it is rather easy to palpate if it is definitely thickened. It extends forward from a point just anterior to the lobule of the ear, coursing downward, below the zygomatic process. It is best palpated by gentle pressure applied from below, forcing the thickened nerve upward toward the zygoma. (This nerve was found thickened in four patients, in two instances by inspection; in one case the enlargement was bilateral. These cases are not included in the Table 1 because, at the time of reexamination of the cases discussed in this paper for those data, none of the four patients still showed the specific involvement.)

The cervical nerves are very commonly involved, and in about the following order of frequency: great auricular, transverse cervical (cutaneous colli), supraclavicular, and lesser occipital. They all emerge posterior to the sterno-cleido-mastoid muscle at about its middle third.

The great auricular, which runs upward and forward toward the lobe of the ear, slightly behind and roughly parallel to the external jugular vein (Fig. 1), is the most easily seen of all thickened superficial nerves. To make it stand out prominently one needs only rotate the head away from the side being examined to tense the underlying sterno-mastoid muscle. It is easily palpated with the fingers at right angles to the nerve.

The transverse cervical, if thickened, is also easily visualized and palpated. It lies transversely across the neck, in a superficial position anterior to its point of emergence; and turning the patient's face toward the opposite shoulder brings it into better view. It is best palpated while the head is held in that position (Fig. 2).

The supraclaviculars are brought into view by rotating and flexing the head slightly toward the opposite side and at the same time exerting pressure with the fingers just below the clavicle (Fig. 3). Any one of the three branches may be observed and palpated as it extends downward over the clavicle.

The lesser occipital is less commonly seen than the foregoing nerves, since it is partially hidden by the posterior portion of the sterno-mastoid muscle. Its course is up along the posterior belly of the muscle to supply the scalp (Fig. 4). It is most easily palpated by gentle pressure of the fingertips posterior to the nerve, forcing it against the muscle.

Nerves of the upper extremity.—Leprous involvement of the nerves of the arm is less frequently evident on inspection than is that of the nerves of the head and neck. Nevertheless, the ulnar, radial, median, antibrachial cutanei and dorsal cutanei nerves of the upper arm and forearm are quite frequently involved, and may then be easily palpated.

The ulnar is one of the most commonly involved nerves, and its terminal branch as well as the main trunk should be investigated. The latter is most easily visualized when viewed from behind the patient with his arm slightly flexed and rotated anteriorly (Fig. 5). It is most easily palpated when the examiner faces the patient and, with his opposite hand, grasps the arm to be examined at the wrist and flexes it to about a right angle. With the fingers of the other hand the examiner then feels for the nerve trunk in the interval between the medial epicondyle of the humerus and the olecranon process, following the nerve up along its course. It is most easily located by passing the hand medially to the patient's arm, in contradistinction to the best method of palpating for enlarged epitrochlear glands. It is most commonly enlarged just above the olecranon.

The small distal branch of the ulnar is quite frequently thickened, and

it may be involved when the main trunk is apparently normal. (In one patient this was the only superficial nerve found involved.) It is best seen as it extends onto the posterior surface of the hand below the distal end of the ulna (Fig. 6). It is most easily palpated by standing in front of the patient, grasping his hand with its palm down with examiner's opposite hand palm down; then, with the index finger of the same hand, the examiner exerts gentle pressure which forces the nerve against the cuneiform bone.

Thickening of the main trunk of the radial nerve was not visualized in any of the patients, although thickened trunks were palpated. This nerve may be palpated by exerting sufficient pressure to force it against the bone at some point along its course downward around the posterolateral surface of the middle third of the humerus. The distal cutaneous branch of the radial nerve (radial superficialis) was observed and palpated in several patients (Fig. 7).

When involved the antebrachial cutaneous and dorsal cutaneous nerves of the forearm, although well covered, may at times be seen (Fig. 8), but they are more frequently palpated. These nerves are best palpated by moving the fingertips down the patient's forearm in a crisscross fashion from the elbow to the wrist. The patient's cooperation is of particular assistance in distinguishing nerves from tendons and blood vessels in this examination.

Nerves of the lower extremity.—One seldom finds definite involvement of the nerves of the upper thigh, but there may be marked involvement of those of the lower thigh and the leg.

The common peroneal, palpated in the lateral portion of the popliteal space, may be noticeably thickened (Fig. 9). Its superficial branch is one of the nerves most commonly involved—and one of the three most commonly examined. It is best palpated by having the patient sit with the feet resting on the floor, the examiner standing facing him and passing his adjacent hand laterally to the upper portion of the patient's lower leg. The fingertips, after locating the head of the fibula, are moved one inch downward and backward, and then with gentle pressure upward and outward, forcing the nerve as it emerges from the popliteal space against the neck of the fibula.

The branches of the superficial peroneal in the foot may be brought into view by slightly rotating the foot medially and extending the ankle (Fig. 10). The branches may be palpated with the fingertips at right angles to the nerves.

The saphenous nerve (Fig. 11) is seldom involved to the extent that it may be seen. (In one case, however, it appeared to be at least three-eights of an inch in diameter.)

The sural nerves, if thickened, cause the overlying skin to appear as lines extending from the popliteal spaces toward the ankles near the midline (Fig. 12).

STATISTICAL DATA

Statistical data on the frequency of enlargement of the various superficial nerves in the patients at the Kalihi Hospital were collected at a time when there were 140 of them there. Of that number, 117 ambulatory ones were examined—all who were

considered well enough or in good enough condition to be examined extensively, none being chosen because of any particular involvement. They represented the ordinary run of leprosy cases in Hawaii, and included old, young and middle-aged, with all types and phases of the disease.

The nationalities represented were: Hawaiian, 33; part Hawaiian, 37; Portuguese, 11; Japanese, 10; Filipino, 9; Chinese, 8; German, 5; Korean, 2; Scotch, 1; and American, 1. The sex distribution was: males, 69; females, 48. The ages ranged from 8 to 65 years, the distribution, together with the bacteriological findings, being as follows:

Age group	Number	B+	B—
8 to 16 years	34	30	4
17 to 25 years	28	28	0
26 to 40 years	34	28	6
Over 40 years	21	18	3
Totals	117	104	13

Of the total of 117 cases examined, 104 (88.9%) were found to have one or more thickened superficial nerves; only 13 (11.1%) were negative. There was no evidence of a sex factor, males and females being affected about equally. The number of involved nerves averaged more than five per patient. In one case there were thirty of them, and several patients averaged ten. On the other hand, 14 patients showed but two thickened nerves each, and 2 had only one each—one of them a supraclavicular, the other the distal branch of the ulnar.

The frequencies with which particular nerves were found to be enlarged, either unilaterally or bilaterally, are shown in Table 1. It will be noted that those which were most commonly involved were the great auricular, ulnar, superficial peroneal and its branches, transverse cervical and supraclaviculars, in that order. There was little difference in the frequency of involvement on the right and left sides of the body except with the superficial peroneal. In view of the stress laid on superficial nerve enlargement by the Calcutta workers, and of evidence that in certain other places (Ceylon and the Philippines) the condition is less frequent than there, it is of more than passing interest that with respect to many nerves the frequencies of involvement were higher in my cases than in those of Chatterji. This is notably true of the supraorbital, the great auricular, and even the ulnar; only with respect to the radial and the common peroneal were his percentages the higher.

TABLE 1.—*Frequencies and distribution of superficial nerve enlargement in 117 cases, with Chatterji's percentages for comparison.*

Name of nerve	Cases involved		Unilateral		Bilateral	Chatterji's percentages/*
	Number	Per cent	Right	Left		
Supraorbital	9	7.7	3	4	2	1.6
Great auricular	83	70.9	10	7	66	18.9
Transverse cervical	26	22.2	9	4	13	
Lesser occipital	1	0.8	0	0	1	
Supraclavicular	15	12.8	5	4	6	
Ulnar	82	70.1	13	11	58	56.9
Radial	4	3.4	0	0	4	9.6
Lateral antebrachial	9	7.7	1	3	5	
Medial antebrachial	11	9.4	2	2	7	
Median	9	7.7	2	0	7	
Dorsal antebrachial	6	5.1	2	2	2	
Common peroneal	4	3.4	1	0	3	
Superficial peroneal	53	45.3	20	4	29	53.5
Lateral branch of same, in foot	33	28.2	9	8	16	
Medial branch of same, in foot	20	17.1	4	2	14	
Saphenous	9	7.7	3	1	5	1.0
Sural	6	5.1	1	2	3	1.4

* Frequencies reported by S. N. Chatterji (1933) among 1,024 cases with nerve enlargement. One item, "antibrachial cutaneous," had 2.7%; all other nerves specifically mentioned in both tables were less than 1% in that of Chatterji.

TYPES OF NERVE LESIONS AND SEQUELAE

Several types of involvement of superficial nerves were noted in these cases: (*a*) a generalized thickening extending from the cutaneous branches up to and including the main trunk; (*b*) a cigar-shaped or lenticular thickening of the main trunk; and (*c*) a node-like thickening of the trunk.

The nodes referred to might be one or several, and might be located on one side of the nerve or involve the entire trunk within the sheath. It was observed that they might break down and form abscesses within the sheath; and that structure was usually found, on dissection of the abscess, to serve as a capsule over the node. In some instances the nerve bundles appeared to be spread apart by the leprous granulation tissue, while in other instances the bundles were so incorporated in the leprous tissue that it was impossible to differentiate one from the other. When

liquefaction of the node occurred the nerve was usually hopelessly destroyed.

Though the caseation basic to nerve abscess was recorded prior to 1900, and though Muir (9) and Lowe (6) reported the occurrence of abscesses in India in the 1920s, special attention has been given this sort of lesion only since the time this work was done. Lowe (7), to supplement the description by Wade (22) of a specimen which Lowe had given him, contributed a summary clinical note on the subject, and Chatterji (3) diagrammed the sacular type. Since then there have been numerous reports dealing directly or indirectly with nerve abscess, all for which references have been encountered, except one (18), emanating from South America (13, 16, 14, 21, 17, 4). From those reports, and from a symposium on the subject (19), it appears that this condition is fundamentally one of tuberculoid leprosy.

The involvement of a nerve may be part of a very acute, reactional process or one of slow and progressive development. When the process is acute there is usually edema within the sheath which causes pressure on the nerve, and that condition gives rise to intense pain. Acute leprous neuritis is probably the most painful condition experienced in the disease. When, on the other hand, the involvement is slow and progressive many forms of dysesthesia may be complained of by the patient, and anesthesia to heat, cold and pain may develop. In the chronic form the pain is less severe and may never cause complaint.

It is surprising how rapidly paralysis and atrophy of muscles may develop following the onset of leprous neuritis. In from twenty-four to forty-eight hours after the onset one side of the face may show a definite droop, or an ankle or wrist-drop may develop. The atrophy of muscles in leprosy appears to be more rapid than those which result from the commoner diseases, so that definite increase in the degree may be noted from week to week. On the other hand, there may be marked thickening of nerve trunks with very little apparent paralysis. In such instances the infiltration is usually outside of the nerve bundles and the nerve fibers are not destroyed. In certain cases paralyses slowly become less marked; dropped feet recover and drooped faces become less asymmetrical.

REPORTS OF CASES

(1) The case which initiated this study was that of S. U., a Japanese male aged 44, admitted to the Kalihi Hospital on April 17, 1930. The type was neural, with a few skin lesions of the macular and ring varieties, principally on the trunk and arms. His lack of fat caused the nerves to stand out more prominently than they would have done on a person of better nutrition, and at the first inspection with good light the cervicals and common peroneals stood out like cords (see Figs. 2 and 9). By inspection and palpation it was determined that 30 superficial nerves

were thickened. The terminal branch of the ulnar which passes onto the posterior surface of the hand below the distal end of the ulna was easily palpated, about 3/32 inch in diameter; the ulnas were about 3/8 inch, the common peroneals at least 1/2 inch, and the antibrachials about 1/4 inch. The patient cooperated splendidly and soon learned to demonstrate his abnormal nerves to the many physicians who came to examine him. In the course of time muscular atrophy increased; skin lesions which had assumed a more normal appearance would again become active; and some of the nerves returned to a more normal size while others, apparently normal on the first examination, became involved. In the spring of 1933 the patient developed a peculiar involuntary intermittent movement of the right arm which was thought to be due to some irritation of the superficial motor nerves. The right suprascapular nerve was then found definitely thickened and extremely painful to palpation; it could be felt along its course under the spine of the scapula after winding around the great scapular notch.

(2) K. K., a Hawaiian male aged 25, entered the infirmary of the Kalihi Hospital on July 22, 1932, with an acute generalized eruption. Many superficial nerves were found thickened and tender to pressure. He complained of pain in the arms and legs, and certain areas of intense pain which he pointed out were found to be the sites of involved nerves. The nerve trunks in the regions could be palpated. (In other patients complaining of pain, thickened tender nerve trunks were discovered during periods of exacerbation of skin eruptions. Many patients during reactions never complain of pain, though most of them have concomitant skin and nerve involvement.)

(3) K. G. J., a Korean female aged 36, was admitted to Kalihi Hospital on August 9, 1932, for treatment of acute neuritis involving principally the left ulnar, left transverse cervical, and left superficial peroneal nerves, the leprotic nature of which was confirmed. Faintly pink hypopigmented macules were present on the pectoral region, the left upper arm and forearm, and the left suprascapular region. The one on the pectoral region was anesthetic to tactile and thermal stimulation. The temporofacial branches of the left facial nerve, the left great auricular, transverse cervical and occipital nerves, the left ulnar, and the left common and superficial peroneals were thickened and tender. The left ankle and foot were swollen and painful. The onset of leprosy seemed to have been in the nerves primarily.

(4) M. A., a Filipino male age 32, was admitted to Kalihi Hospital on June 28, 1932. Two weeks previously he had consulted his physician for a painful swelling in the cervical region, and a local dressing was applied. When he returned to the physician with a generalized wheal-like eruption and more severe pain in the neck he was sent to the Kalihi Hospital because of a suspicion that the condition was leprosy. Because of swollen hands, feet and face, a generalized wheal-like eruption, and neuritis he was placed immediately in the infirmary. On removing the dressing on the cervical region, a piece of belladonna plaster, a markedly thickened left great auricular nerve was exposed. Both great auriculars, and also the ulnar and superficial peroneal nerves, were thickened and painful to pressure. This case demonstrated an acute onset of leprosy with a primary superficial nerve involvement which antedated any known skin lesions by at least two weeks.

(5) L. C., a part-Hawaiian female aged 27, entered the Hospital infirmary on May 19, 1932, with an acute leprous eruption consisting of large infiltrated areas, and a generalized superficial neuritis with thickening of many nerves. The distal branches of the radials and ulnars were very prominent, and the lateral and median branches of the left superficial peroneal were nodular. All nerves involved were tender to pressure. On July 8 she was returned to ambulatory status. During the interval the cutaneous lesions had almost disappeared, although the nerves were still thickened but not tender. Four months later it was difficult to palpate any of the nerves previously found thickened, and the condition was considered clinically quiescent.

During two separate studies of about one hundred children of leprous parents in Honolulu, done in conjunction with Surgeon N. E. Wayson, director of the Leprosy Investigation Station, all suspicious signs of leprosy were noted. The object of those studies was to learn the signs on which a tentative diagnosis of leprosy could be made before the disease could be clinically diagnosed from skin lesions, anesthesia or positive bacteriological findings (25). Among the signs considered most important were thickened superficial nerves. Only those nerves which were found thickened by both examiners, each having made an independent examination without the knowledge of the findings of the other, were considered involved. The suspicious cases at the boys' home were reexamined at intervals for developments, and within a year following the initial study five out of sixty of the boys—all under fifteen years of age, the youngest of them eight years—were admitted to Kalihi Hospital as definitely leprous. All of them had showed thickened superficial nerves at the primary examination.

SUMMARY AND CONCLUSIONS

The results of a comprehensive survey of over 500 leprous parents in Hawaii during the course of some three years revealed marked frequency of involvement of the superficial nerves. A method of clinical examination by inspection and palpation for individual nerves is described.

The results of an intensive study of 117 ambulatory patients at the Kalihi Hospital are tabulated to show those nerves which are most commonly involved. A number of photographs illustrating observable enlargement of various nerves are presented.

Notes on five cases are given to show the involvement of superficial nerves in the early stages of the disease. They demonstrate that during cutaneous exacerbations the superficial nerves are commonly involved.

Repeated intensive examinations of the children of leprous

parents impressed the examiners with the fact that the superficial nerves may be involved and demonstrable before other characteristic signs are present, thus enabling one to diagnose incipient leprosy.

The opinion is expressed that the finding of definitely thickened superficial nerves, in a suspicious case, is one of the most important signs in a differential diagnosis of leprosy. In bacteriological negative cases the findings of thickened superficial nerves in conjunction with anesthetic areas and cutaneous lesions clinches the diagnosis of leprosy.

The author feels that all children of leprous parents, all close contacts with leprous patients, and all suspected children in an endemic leprous center should be studied routinely every six months for involvement of the superficial nerves.

ACKNOWLEDGMENTS

The execution of this study was greatly facilitated by the advice and assistance of Surgeon N. E. Wayson, director of the Leprosy Investigation Station, Honolulu, and of Dr. J. T. Wayson, physician, and H. A. Klugel, superintendent, of the Board of Leper Hospitals and Settlement, which is gratefully acknowledged.

Credit is given to Dr. H. W. Wade, Editor of THE JOURNAL for revising the original manuscript, reviewing the literature and bringing the article up to date.

REFERENCES

1. CHATTERJI, S. N. Thickened nerves in leprosy in relation to skin lesions. Internat. J. Lep. **1** (1933) 283-292.
2. CHATTERJI, S. N. The early manifestations of leprosy as seen in an out-patient clinic. Lep. in India **8** (1936) 6-10; *abstract in* Internat. J. Lep. **4** (1936) 397.
3. CHATTERJI, S. N. Neural affections in leprosy and their diagnosis, pathology and treatment. Indian Med. J. **30** (1936) 414-419; *reprinted* Internat. J. Lep. **5** (1937) 329-341.
4. GARZON, R. and ARGUELLO PITT, L. Neuritis leprosa tuberculoide a forma de abcesos caseos multiples. Rev. argentina Dermatosif. **27** (1943) 247-257; *abstract in* Internat. J. Lep. **11** (1943) 98.
5. LAEHR, quoted by Monrad-Krohn, p. 60, reference 8.
6. LOWE, J. Nerve abscess in leprosy. Indian Med. Gaz. **64** (1929) 24-25.
7. LOWE, J. A further note on nerve abscess in leprosy. Internat. J. Lep. **2** (1934) 301-304.
8. MONRAD-KROHN, G. H. The Neurological Aspect of Leprosy ("Spedalskhed"). On commission by Jacob Dybwad, Christiania, 1923.
9. MUIR, E. Nerve abscess in leprosy. Indian Med. Gaz. **59** (1924) 87-89.
10. MUIR, E. The early diagnosis of leprosy. Lep. Rev. **1** (1930) 4-8 (No. 4).
11. MUIR, E. and CHATTERJI, S. N. Leprous nerve lesions of the cutis and subcutis. Internat. J. Lep. **1** (1933) 129-148.
12. MUIR, E. and CHATTERJI, S. N. A study of nerve leprosy. Indian J.

Med. Res. **24** (1936) 119-138; *abstract in* Internat. J. Lep. **6** (1938) 268.

13. RIBEIRO, E. B. Aspectos cirurgicos da caseose das nervos na lepra. Sociedade Editoria Medica Lin, São Paulo, 1934; *abstract in* Internat. J. Lep. **3** (1935) 256.
14. RIBEIRO, E. B. Achado cirurgico em um caso de lepra nervosa considerado extinto. Rev. brasileira Leprol. **6** (1938) Special No. pp. 175-178; *abstract in* Internat. J. Lep. **9** (1941) 132.
15. RODRIGUEZ, J. N. and WADE, H. W. The status after five years of neural leprosy cases studied in Cebu. Internat. J. Lep. **7** (1939) 309-326.
16. SCHUJMAN, S. Coexistencia de abceso nervioso y lepra tuberculoide. Rev. Leprol. São Paulo **2** (1935) 27; *abstract in* Internat. J. Lep. **4** (1936) 400.
17. DE SOUZA CAMPOS, N. and RIBEIRO, E. B. Nevrite e caseose de nervo na lepra tuberculoide. Ann. Paulista Med. Cirurg. **6** (1941) 527-529; *abstract in* Internat. J Lep. **10** (1942) 161.
18. STEIN, A. A. and WYSCHENEWSKY, A. A. Ein Fall von Lepra mit kaseösen Veränderungen in den Nerven. Internat. J. Lep. **9** (1941) 305-308.
19. [SYMPOSIUM] Nerve abscess in lepromatous cases. Internat. J. Lep. **7** (1939) 274-276 (corresp.).
20. THIN, GEORGE. Leprosy. Percival and Co., London, 1891.
21. VIEGA DE CARVALHO, S. Contribução para o estudo de cirurgia de nervo cubital na lepra. Rev. brasileira Leprol. **6** (1938) 431-441; *abstract in* Internat. J. Lep. **8** (1940) 252.
22. WADE, H. W. Tuberculoid changes in leprosy. III. The pathology of a nerve abscess. Internat. J. Lep. **2** (1934) 293-300.
23. WADE, H. W. The skin lesions of neural leprosy. I. General introduction. Internat. J. Lep. **4** (1936) 409-430.
24. WADE, H. W., DE SIMON, D. S. and FERNANDO, A. C. Idem. V. Observations in Ceylon. Internat. J. Lep. **6** (1938) 199-221.
25. WAYSON, N. E. The early diagnosis of leprosy; the first clinical findings observed in segregated children of leprous parents. Internat. J. Lep. **4** (1936) 177-188.
26. WAYSON, N. E. and BADGER, L. F. Studies upon leprosy. XLIX. Clinical observations of "early" or moderately advanced cases. Public Health Bulletin No. 189, 1929, pp. 1-16.

DESCRIPTIONS OF PLATES

PLATE 1.

FIG. 1. Showing marked thickening of the right great auricular nerve.

FIG. 2. Showing a thickened right transverse cervical (cutaneous colli) nerve coursing forward across the sternocleidomastoid muscle. The supraclavicular and great auricular nerves are also thickened.

FIG. 3. Showing thickening of the supraclavicular nerves, and the method of demonstrating their involvement. The great auricular and transverse cervical nerves are also enlarged.

FIG. 4. Showing marked thickening of the right lesser occipital nerve, as well as of the great auricular.

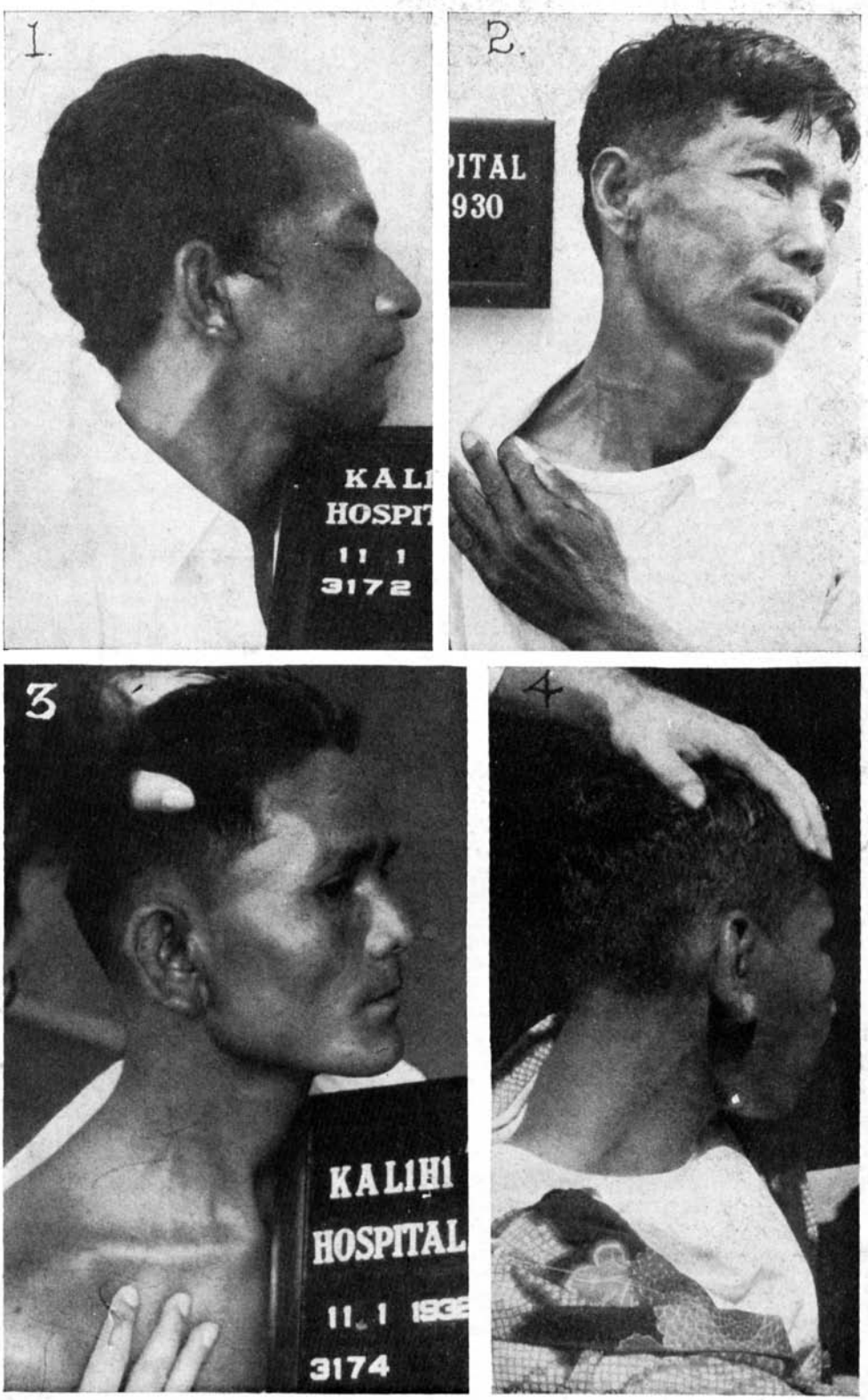

PLATE 1.

PLATE 2.

FIG. 5. An enlarged right ulnar nerve runs upward and medially from the notch between the medial epicondyle of the humerus and the olecranon process. Note also the thickened antebrachial cutaneous nerves.

FIG. 6. Demonstrating thickening of the distal superficial branch of the right ulnar nerve.

FIG. 7. Demonstrating thickening of the distal branch of the left radial nerve, the branches of which form an inverted y-shaped figure over the first metacarpal bone.

FIG. 8. Showing thickening of the medial antebrachial cutaneous nerve.

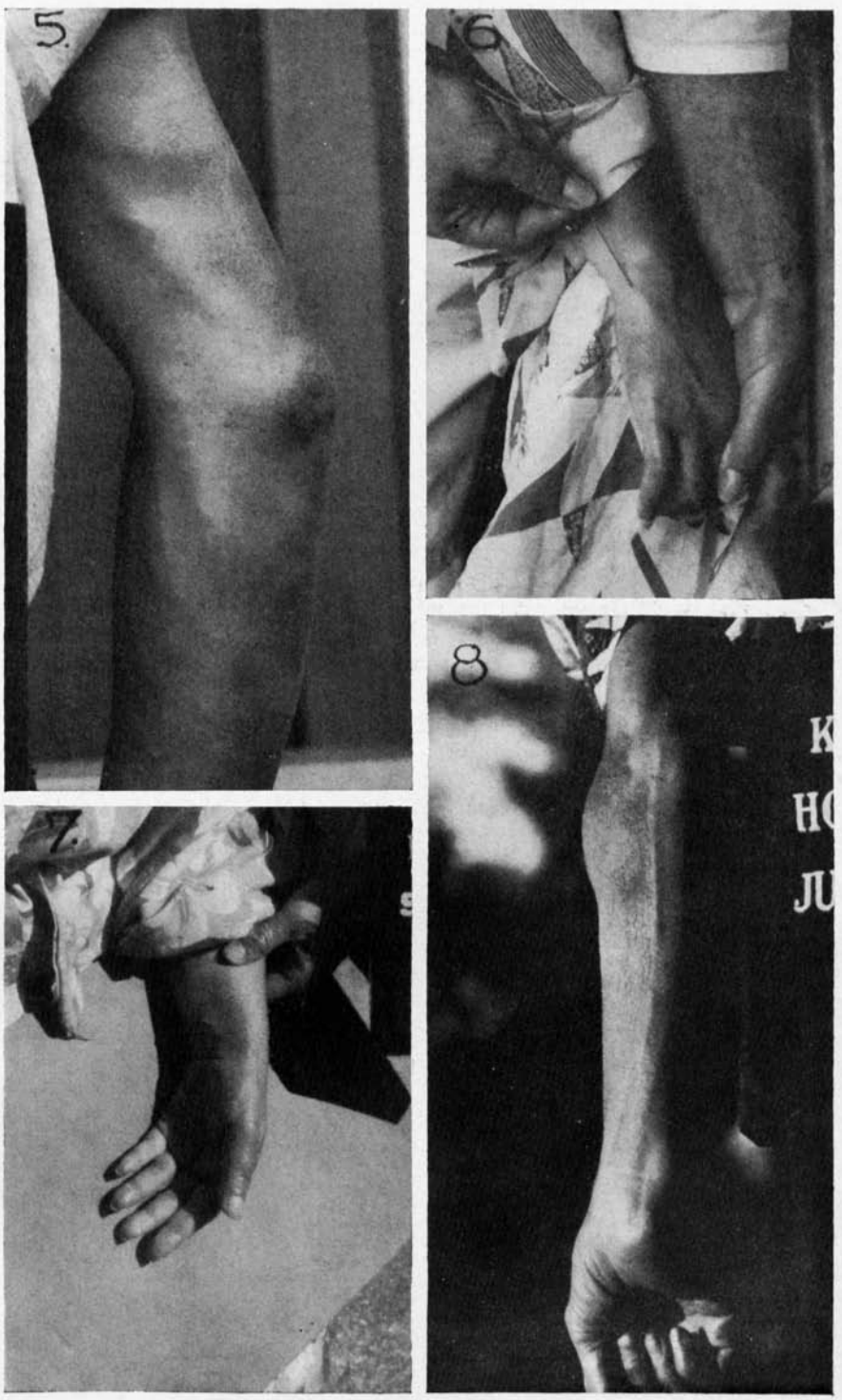

PLATE 2.

PLATE 3.

FIG. 9. Marked thickening of the common peroneal nerves at the lateral borders of the popliteal spaces. Note also the thickened right saphenous nerve medial to the popliteal space, and the lateral dorsal cutaneous nerve behind and below the right lateral melleolus.

FIG. 10. Showing thickening of the medial and lateral branches of the superficial peroneal nerve, and the method of demonstrating the nerves for inspection.

FIG. 11. Marked thickening of the left saphenous nerve.

FIG. 12. Thickening of the medial sural cutaneous nerves. Note also the thickened right saphenous nerve in the thigh, which is a continuation of the nerve shown in Fig. 11.

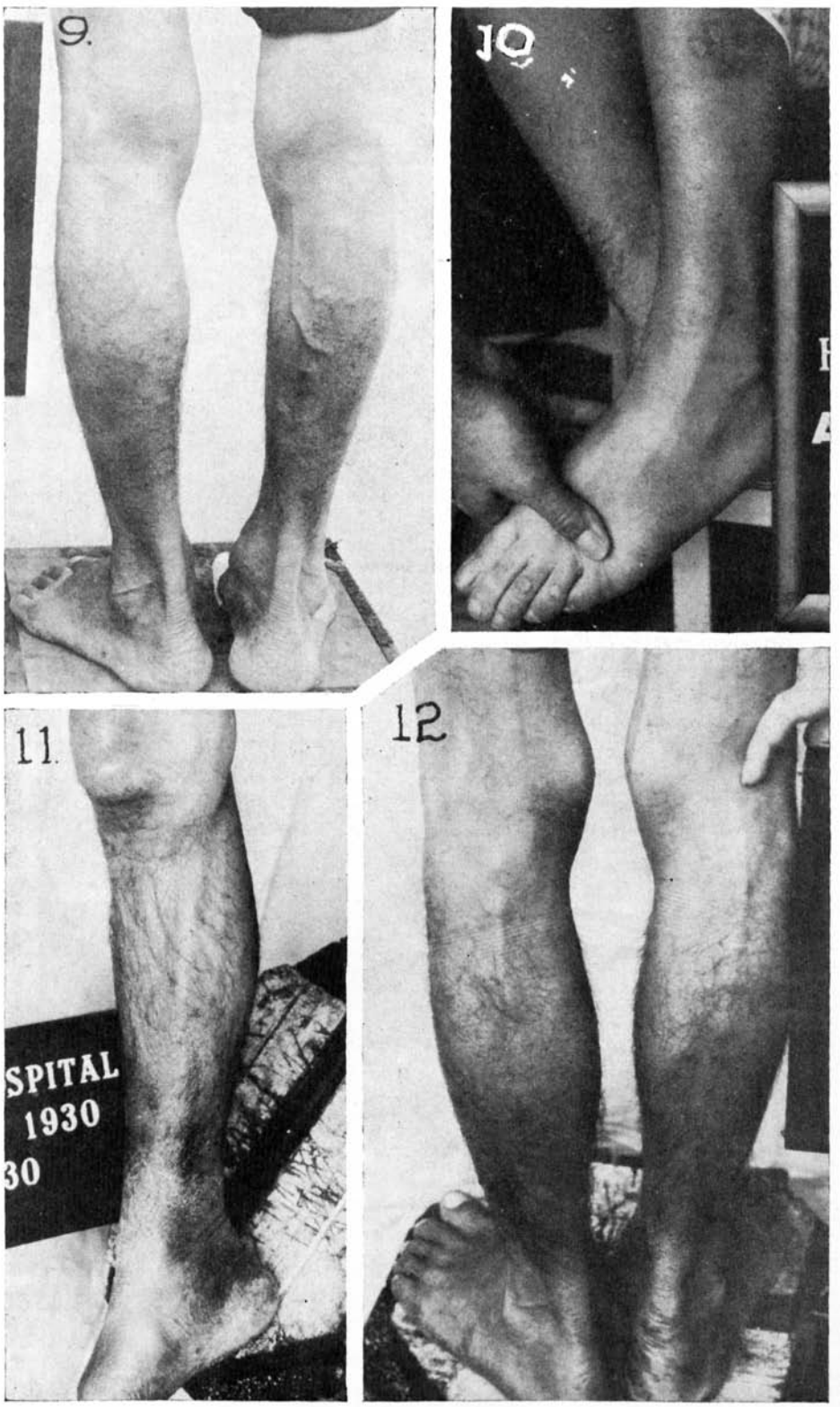

PLATE 3.