STUDIES ON PLANTAR ULCERATION IN LEPROSY

VI. The Management of Plantar Ulcers

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The management of plantar ulcers in leprosy reflects the uncertainty as to the cause of the condition, and has been largely discouraging. Trophic ulceration of the foot is not peculiar to leprosy but occurs in other neuropathies, including tabes dorsalis, syringomyelia and diabetes mellitus. It is therefore the expression of a lesion common to these widely diverse diseases. The present studies support the contention that the responsible factor is a failure of the mechanisms which protect normal plantar tissues from the damage which would otherwise result from the pressures and frictions of walking.

The methods of treatment which have been advocated cover a wide field, ranging from local injections of anti-leprosy drugs (Cochrane, 1940, Dharmendra *et al.* 1955, Ekambaram, 1960) to methods aimed at control of mechanical factors, e.g., novocaine blockade (Vischevsky, 1938) or local excision of tissue (Newman *et al.* 1955). The only consistent observation is that the use of a plaster cast permits healing if it is continued long enough. The earliest reference to this appears to be that of Khan (1939) and represents the application of principles enunciated by Trueta in the treatment of war wounds during the Spanish civil war. The success of the method has been confirmed by several observers (Milroy Paul, 1947, Fisher, 1955, Bose, 1956) and by the present writer. Healing proceeds under a plaster cast without local treatment, without relief of pressure, without antibiotic therapy; and it can only be concluded that the essential factor is mechanical. The reluctance of many to employ this method stems undoubtedly from a natural fear of applying plaster to an anaesthetic foot, and to the frequency with which the ulceration recurs after removal of the plaster.

The important questions are why does a plaster cast permit healing and why does the ulcer recur after removal of the cast? The answer appears to be that the active factor promoting healing is control of the movements of extension, under pressure, of the various flexures of the sole; and control of the rotations under pressure, round the point of contact at the heel and push-off at the tips of the toes during each step of walking. The ulcer recurs because these movements are renewed when walking is resumed.

The solution of the problem of plantar ulceration can be summed up as follows: the control of plantar damage during walking, the

avoidance of ulceration, and the control of infection and of loss of skin if ulceration does occur.

It is stressed that ulceration need not occur, and is a serious complication of the plantar lesion. The management of the condition is therefore discussed under the headings:

1. The pre-ulcerative stage.
2. The stage of frank ulceration.
3. The stage of healed ulceration (threatened recurrence).

1. The Management of the Pre-Ulcerative Stage

If ulceration is avoided, the disabilities of the neuropathic foot are largely obviated. To avoid ulceration, there is no substitute for regular inspection of the feet by a trained observer. It should be a maxim of leprosy treatment that regular hand and foot inspection is a necessity for rehabilitation. This is especially the case when the patient himself cannot be relied upon to observe and report early signs and symptoms of foot damage. If treatment is to be carried out adequately, a method of recording rapid and accurate observations is essential. The following is found to serve well:

(*a*) Record the extent of anaesthesia to light touch (Fig. 1). The degree of sensation to light touch is tested by light stroking with a feather and recorded on charts of the plantar, medial, and lateral aspects of the foot. The feather is drawn centrally from the tips of the toes along the sole and towards the knee. It is unnecessary to denote the upper limit of anaesthesia reaching above the ankle. The observer will be surprised to find how sensitive is the normal sole of barefooted people to this minimal stimulus.

(*b*) Record or indicate on a chart the areas of actual and possible plantar damage, or use a system of abbreviations (Fig. 2).

The presence of an ulcer should not detract from the importance of palpating the other classical points of plantar damage.

(*c*) Assess the extent of loss of skin. The diameter of the ulcer in cm. serves to indicate the minimal extent of loss of skin. Any gain in skin that could be obtained by traction on the edge of the skin is certainly offset by the loss due to poor viability of the skin and its fixation to the underlying tissues by infection.

(*d*) Estimate the degree of involvement of deep tissues. Infection must first be controlled, and this may call for prolonged treatment if bone is involved. An X-ray is useful but underestimates the extent of bone infection. A useful clinical guide is the amount of discharge from the ulcer or sinus. The cessation of discharge is a favourable sign, but it is stressed that chronic bone infection may be ineradicable. Extensive scarring of the plantar tissues following infection may render the foot incapable of rehabilitation for walking, even when the infection is eradicated.

Using the above methods of recording the clinical condition, the *initial control of neuropathic feet* can begin. The following is a suitable procedure:

(*a*) Examine every patient for anaesthesia of the sole to light touch.

(*b*) Cases without anaesthesia are excluded from further immediate observation.

(*c*) Cases with anaesthesia are then examined in detail and the results recorded.

The patient sits before the examiner and rests his Achilles tendon on a support so that the whole sole is visible. The toes are observed for degree of spreading, and the plantar surface for breaches of skin or areas of callosity. The danger areas are then systematically palpated while the patient is kept under scrutiny for signs of discomfort. Localised swelling is also sought at these areas.

In the early days of control, it may be better to let pass some cases that appear suspicious, so as not to increase the number of patients to be treated, as this number will be surprisingly large; but it is safer to regard any cases with local swelling, local tenderness to palpation, or local splaying of the toes as potential cases of ulceration.

The patients will then be divided into groups, those without anaesthesia, those with anaesthetic soles but without localising signs of plantar damage, those with anaesthetic soles but with localising signs, and finally, those with plantar ulceration. Treatment for each group is then instituted as described below.

The initial control of a leprosarium of 500 patients will take a month before treatment can be begun. It is as important to exclude those who can be safely excluded as to include those who ought to be under observation.

After the initial control and initiation of treatment, the second phase begins—that of *routine control* of the feet (and hands) of patients with leprosy. The frequency of inspection depends on the anaesthesia, on the general condition of the patient and on his intelligence.

Those without plantar anaesthesia are examined at three-monthly intervals to record the progress of the nerve damage. This is important even in cases with definite ulceration. It is not infrequent to find that sensation to light touch returns to a sole that presents an ulcer. In these cases, the chronicity of the ulcer is due to underlying bone infection, inadequate skin cover, or to other complicating factors such as circulatory deficiency.

Those with anaesthetic soles are examined at least every two weeks; unco-operative patients need weekly inspection, as do those of low intelligence. Frequent inspections are also needed at periods of special stress on the feet, such as the planting season, or the dry season.

When the leprosarium is under continuous adequate control, the occurrence of any plantar ulceration will be considered as a penetration of the lines of defence that should put the medical attendant on his mettle.

The treatment of threatened plantar ulceration is on the following lines. The patient is put to bed with the foot of the bed raised, though he is allowed to move with the help of a crutch to perform his toilet. The plantar oedema and tenderness will disappear in a week or ten days and the patient then resumes normal activities with rigid sole footwear. Alternatively, the patient remains in bed for three days until the initial oedema has subsided, and a plaster cast is then applied to enable him to be ambulant. The advantage of the latter method is that he can return home until his footwear is ready, work which may be delayed in a busy shoe shop.

2. The Management of Plantar Ulceration

It must be remembered that the principles of plastic and orthopaedic surgery apply to these ulcers as to others. Much of the disappointment in the treatment of trophic ulcers stems from failure of treatment that would be inadequate in the ulcerated foot of an otherwise healthy adult. Long-standing infection is difficult to eradicate in ideal cases. The healing of a large ulcer by scarring will not support the strain of walking in the best feet; extensive deep scarring will not support the pressures and tensions of activity in any case without some support.

The adequate care of plantar ulceration includes the management of infection, and measures against loss of skin.

Management of infection

In general, infection will be overcome if the tissues are protected from repeated trauma and if the circulation is adequate. Antibiotics can speed the healing. The best encouragement of healing is the application of a walking plaster after infection and oedema are controlled. It is not necessary to apply a weight-bearing cast, but one reaching to the tibial condyles will be found more comfortable than a shorter one, and less likely to cause pressure sores. A suitable cast is described in Appendix I.

After control of the oedema and infection by a few days in bed (assisted if desired by the administration of an antibiotic), the simple saline dressing which has been used in bed is replaced by a vaseline gauze cover, and the plaster cast is applied before the patient leaves the bed. When it has dried, the patient begins to walk, assisted at first by a stick or crutch. If necessary, casts can be applied to both feet simultaneously and the patient soon learns to walk as on stilts.

He is seen daily for the first week and any site of pain is exposed by opening a window in the cast; if no skin damage is found, the plaster is repaired. Attention is also paid to the odour at the ends of

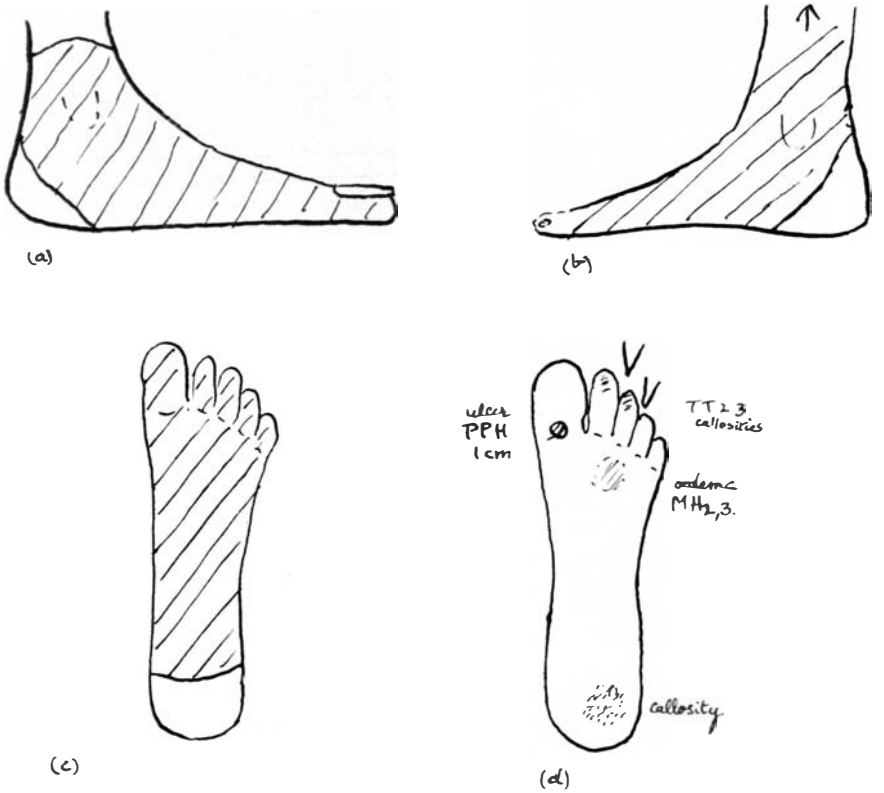

FIG. 1. *Chart for recording foot lesions*

(*a*), (*b*) and (*c*) indicate areas of anaesthesia to light touch. The upper level of anaesthesia above the ankle is unimportant in plantar lesions.

(*d*) represents the extent of plantar damage. The abbreviations are described in Figure 2. The V sign is placed between two toes which show splaying.

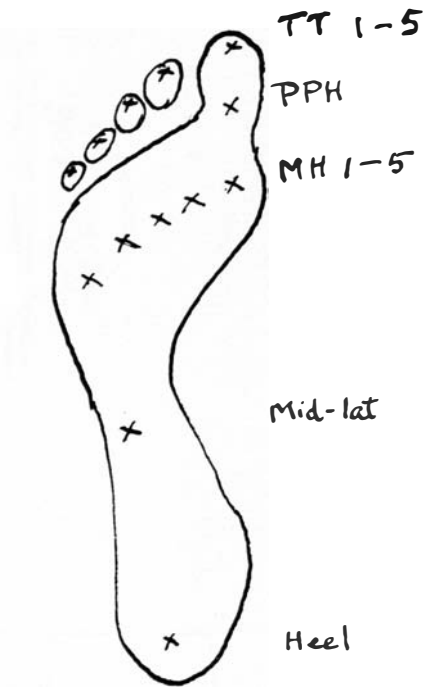

FIG. 2. *Sites of plantar damage*

It is useful to indicate concisely sites of observed damage. The scheme is as follows:

TT	= toe tips
PPH	= proximal phalangeal head (of 1st toe)
MH	= metatarsal head
mid-lat	= mid-lateral (tubercle of 5th metatarsal)

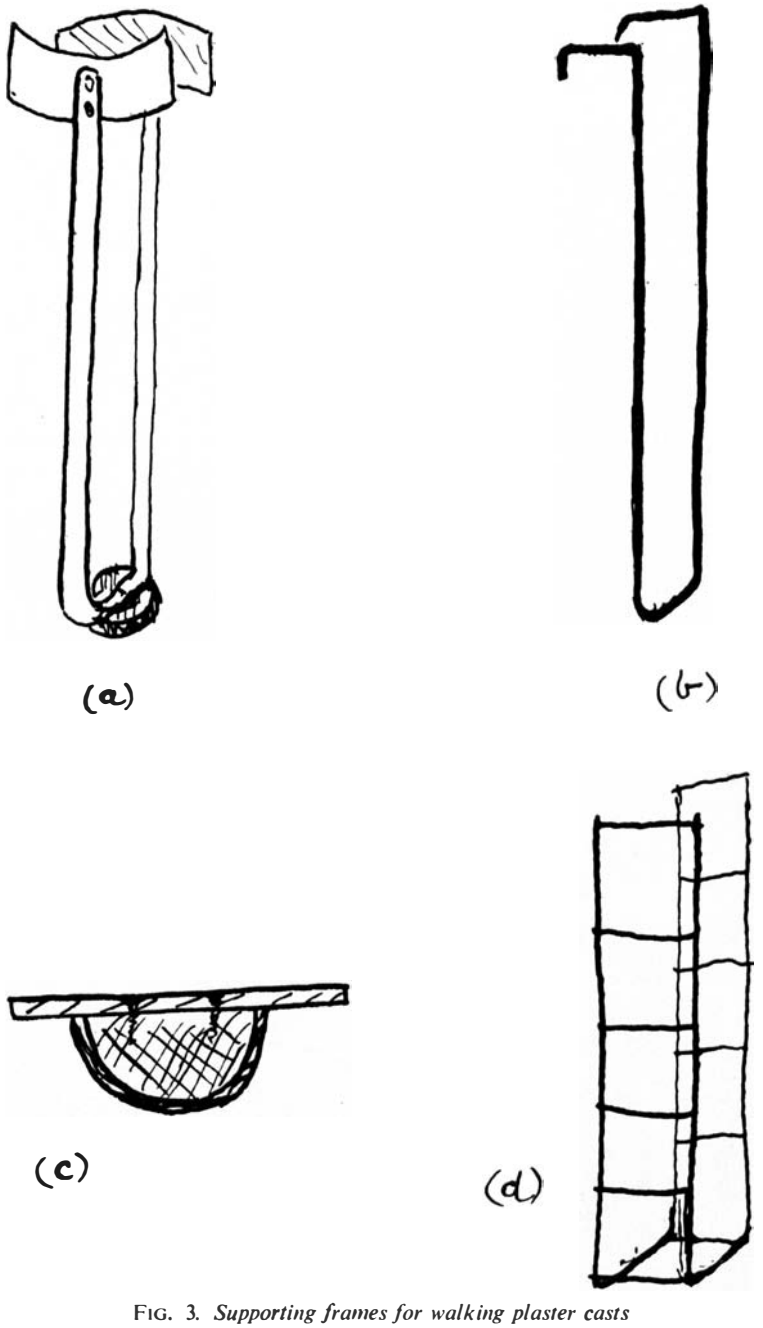

FIG. 3. *Supporting frames for walking plaster casts*

(*a*) the common U-iron is made of steel band, with welded top and rubber heel.
(*b*) a simple substitute is ¼ in. (0.64 cm.) iron rod, used by builders.
(*c*) alternatively, a wooden sole bearing a rocker can be added to a simple cast.
(*d*) another substitute is 3 in. (7.62 cm.) welded mesh, used by builders. This can reach the ground, or be used as a support and incorporate the wooden sole.

In all cases the projecting part beneath the sole must be high enough to enable the toes to clear the ground when walking.

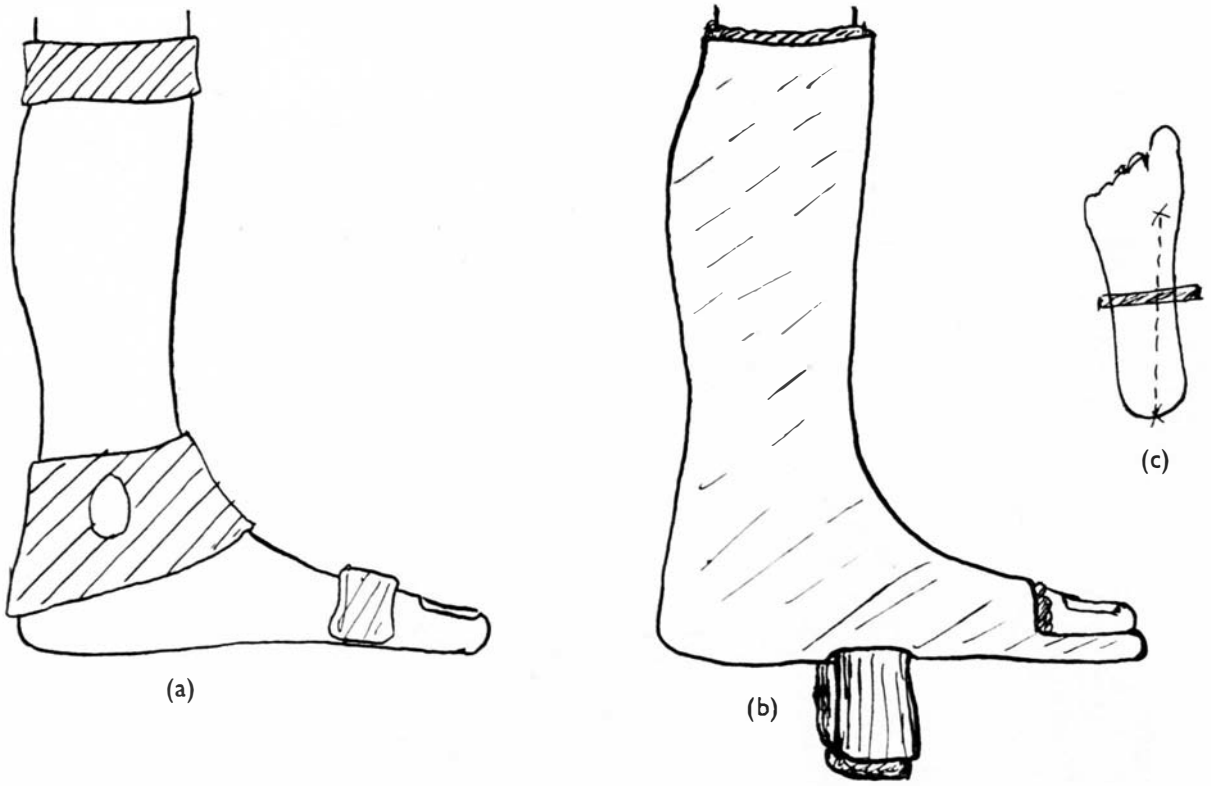

FIG. 4. *The walking plaster cast*

(*a*) Felt padding. This is used at the upper and lower limits of the cast, except across the sole. It is important to protect the tendons in front of the ankle, as well as the malleoli and heel.
(*b*) The adequate cast must support the toes and protect the tips, be sufficiently high off the ground to avoid damage to the 'heel' or 'toe' of the cast when walking, and be supported at the optimal point.
(*c*) Optimal point of support. This is just anterior to the mid-point of a line joining the metatarsal pad to the back of the heel.

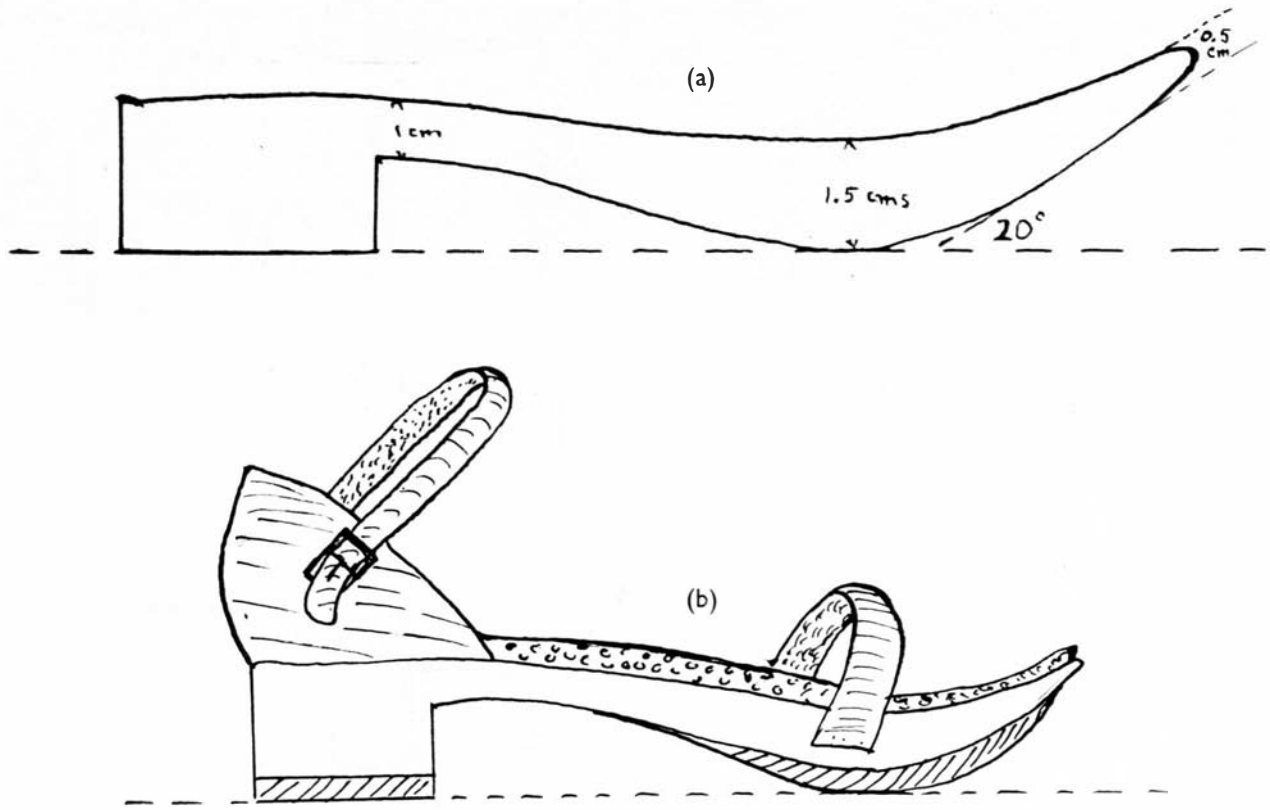

FIG. 5. *The Standard Rigid Sole Sandal*

(*a*) The wooden sole. This must be long enough to protect the toes, and rise sharply enough from the metatarsal pad to make possible the rolling movement needed for walking.

(*b*) The complete sandal. The leather heel piece incorporates a heel stiffener; the straps also are of leather and all are lined with felt. The insole is sponge rubber bonded to canvas as used for carpet underlays. The heel and sole are protected by rubber; special sizes and shapes are obtainable from clog manufacturers.

the cast, and one soon recognises the healthy smell of a healing ulcer from one due to skin damage.

In a short time it becomes possible to apply a cast with confidence securing the absence of traumatic points of pressure.

The cast is then examined weekly after the first week, and is removed after six weeks. In many cases, the ulcer is already healed. If not the cast is reapplied repeatedly until healing occurs. This may take a year in difficult cases. With experience the initial healing can be hastened by the judicious use of Thiersch skin-grafts, but this must not be considered as permanently adequate cover. When healing has occurred, the question of the soundness of skin cover arises.

Management of Skin Loss

This is a problem of plastic surgery, and few except specialised centres will have the necessary skill or facilities. It must be emphasised however that a healed ulcer will break down under stress unless skin cover is adequate. Skin cover is adequate if the area of skin loss is replaced by skin in complete or partial thickness; it is not adequate (except in minimal cases) if cover consists of scar tissue with an epithelial or Thiersch-graft surface. The breaking down of a healed ulcer may therefore represent the call for a plastic procedure beyond the possibilities of a local leprosarium. The ulcer is then 'incurable' under local circumstances. But if adequate footwear is provided scars otherwise precarious may support the strains of walking surprisingly well. Description of adequate footwear now follows.

3. The Management of Healed Ulceration

The healing of a plantar ulcer must be considered as only a stage in the treatment. If further measures are not taken, there is likely to be a recurrence. These measures include provision of special footwear, for which the essentials are a rigid sole and a soft insole. The rigid sole forestalls deep damage between soft tissues and the bony skeleton of the plantar region. The soft insole forestalls damage caused by friction between the skin surface and the immediate points of contact. The writer has found that the above criteria are best met in Africa by the use of wooden soles, carrying a sponge rubber insole. All available alternatives have been tried, plastics, rubber tyres, felt, etc., but found unsatisfactory for various reasons.

A foot without deformity can be fitted with a standard sandal (Appendix 2) but any marked deformity from scarring necessitates specially prepared footwear (Appendix 3). Regular foot inspection is as important for those with footwear as for those without, inspection which includes the footwear as well as the foot.

In brief, rigid sole footwear is indicated for all cases which fall into the following categories:

(*a*) Feet with threatened plantar ulceration.

(*b*) Feet with healed plantar ulceration.

In the early days of control, most cases will be those with recently healed ulcer; but as control proceeds the proportion changes, until finally footwear is only found on patients with threatened ulcer, no cases of actual ulceration being permitted to occur.

The failure of adequate rigid sole footwear to control the occurrence, or recurrence, of plantar ulceration is an indication of the existence of an untreated complication.

For convenience of reference, the common complications are summarised here, though treatment is described elsewhere: an unco-operative patient; inadequate skin cover for the ulcer; persistent bone infection; badly fitting sandals; inadequate circulation, whether hypostatic and connected with lack of exercise, or due to lymphatic or venous blockade: other debilitating conditions, such as diabetes.

The Results of Treatment

A series of cases has been under careful study at Oji River, and the following observations have already been made.

Attendance at the 'ulcer shed' fell from 75 daily to under 15 (not all foot ulcers). The 'ulcer shed' as a part of leprosarium organisation should be no longer necessary.

The early uncomplicated plantar ulcer will heal in about 3 weeks with complete rest in bed, but takes a week longer if treated in a walking plaster from the start.

A simple ulcer of longer duration will take six weeks to heal in a walking cast, and this had been the usual time before removal of the first cast. The longest time necessary to achieve healing was 15 months. There was no obvious correlation between the length of time during which an ulcer had remained unhealed and the time taken to heal under plaster.

Ulcers which had persisted for three years healed sometimes in two months, whereas some recent ulcers took a longer time.

This means that the duration of the ulceration is less important than the actual complications which are present.

It is too early yet to say when, if at all, it will be safe to relax the use of rigid sole footwear. If anaesthesia persists, it can be surmised that special footwear will be necessary permanently, and in this case it will demand the help of a professional shoemaker to conceal (in traditional footwear) the particular therapeutic features.

It can however be confidently expected that the odour, prolonged hospitalisation, and associated unpleasantnesses of the many

cases of chronic plantar ulceration can be averted, and that we can aim at the complete suppression of this complication in leprosy.

Appendix 1. *The Walking Plaster Cast* (*Figs.* 3, 4)

To apply a satisfactory plaster cast for walking, attention must be given to protection of pressure points and of the toes, and to the position of the supporting frame.

Before applying the plaster, the patient should be recumbent with the foot of the bed raised for at least 24 hours in order to combat any oedema present. If this is not done the cast rapidly becomes loose in the first few days.

The skin is best protected with a sleeve of stockinette, but if this is omitted for reasons of economy the hair of the leg should be shaved to avoid the discomfort of hairs trapped in the plaster. It is often wise to sprinkle a parasiticidal powder such as DDT on to the skin before applying the cast.

Pressure points (Fig. 4a) are then protected with a half-thickness of grey orthopaedic felt ($\frac{1}{4}$ in. or 0.64 cm.); this felt readily pulls apart into two layers and is much cheaper than the white variety.

The supporting frame may be of steel, iron or wood (Fig. 3). In either case, the point of support should be just anterior to the midpoint of the line joining the metatarsal pad to the back of the heel (Ruding, 1956). The projecting part must be high enough to prevent the 'toe' of the plaster from scraping the ground at the end of the step.

The toes are protected by ensuring that the plaster sole projects beyond the tips, and is strong enough to give adequate protection. After drying, which must take place in bed before the patient begins to walk, the patient is allowed up and to walk with the help of a crutch or stick (if necessary). A coat of varnish for the cast is a useful protection against water and rain.

After a few days of use the cast will become looser than it was on application. Even if it is obviously weight-bearing, this is not of significance so long as it effectively controls the extension movements of the sole. However, loose casts are more likely to cause friction sores than casts which fit snugly.

Appendix 2. *The Standard Rigid Sole Sandal* (*Fig.* 5).

In providing rigid sole footwear it is convenient to prepare pairs of standard sizes of sandals. This is done after a preliminary survey of the commonly prevailing size of feet in the region. The sole of the sandal is then prepared in wood, and uppers in leather, and the insole in sponge rubber. The best materials depend on local conditions, but in Africa the following were found most suitable after trial of rubber tyres, thick leather, and plastics such as polythene:

Wood is the easiest and cheapest material to work for soles. It is

easy to obtain and can be worked by local craftsmen using their traditional tools. It is best to rely on their judgment as to the best wood to use; a kapok tree provides enough wood for a large leprosarium for over a year. The wood is cut into lengths of a metre or so; the core of heart wood is removed and the segments of trunk are then stacked to dry. Ideally, the wood should dry for a year or more, but work can begin on the fresh wood. The shape of the sole is indicated in Fig. 5a. The sizes given indicate convenient proportions. It is important to note that:

(*i*) the patient's foot should slope slightly downwards, from heel to metatarsal heads;

(*ii*) the sole then rises sharply to the toe of the sandal;

(*iii*) the point of contact of the forefoot underlies the metatarsal heads of the foot, and the sole then rises at an angle of 20° to the ground.

These standards are those that meet the mechanical conditions of the walking forefoot, and are observed in all rigid sole footwear such as clogs, army boots, farm wear.

The *uppers* are made from local leather, and must be soft enough not to chafe the skin. The heel is stiffened by a heel stiffener that fits between two layers of leather as in a pocket. The best and cheapest are the ordinary commercial heel stiffeners supplied to sandal makers. The heel piece must project a definite distance up the back of the heel; if it is too short, it tends to leave the heel at the end of the step, while if it is too long it will cause a friction sore at its upper end. The heel of a normal shoe can be observed for this purpose. The straps are of soft leather, but only the ankle strap needs a buckle. All leather is lined with a half thickness of $\frac{1}{4}$ in. (0.64 cm.) grey orthopaedic felt, using an adhesive.

The *insole* is best made from one of the types of rubber underlay manufactured in Europe and America for carpets. It consists of sponge rubber bonded to a canvas fabric which is readily cut to measure and can be fixed to a wooden sole by adhesive or by tacks. An example is Duralay.

The complete sandal is fitted to the patient, and may need slight modification. The patient is observed daily for the first few days, especially when the anaesthesia extends up the ankle. In some cases it is essential to provide short socks, when the skin is particularly susceptible to injury.

When the patient is discharged and lives or works in a town he will want the characteristics of his footwear to be concealed and this can be done easily by a skilled shoemaker but it is a professional job that will be outside the scope of the average leprosarium.

Appendix 3. *Rigid Sole Footwear for Deformed Feet*

Deformed feet cannot be satisfactorily fitted with standard sandals, and in most cases it is necessary to make special footwear.

It will be noted that in cases where infection has already disorganised the forefoot the desiderata of rigid sole footwear do not apply and the only purpose of the sandal is to protect the foot from injury. Grossly deformed feet may need amputation.

The procedure for a sandal is as follows:

A plaster cast is made of the foot. A wood carver then prepares a negative of the sole on the upper surface of a block of wood from which the sandal will finally be made.

The negative need not be an exact fit but should follow the general contour of the foot. When this is done the sandal is completed as for a standard model; but the position of the point of contact with the ground and of the straps of the uppers will vary from case to case and demands skill and perseverance.

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