PLANTAR DIGITAL NEURITIS

Morton's Metatarsalgia

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"It is high time the profession at large knew that such a distressing and common condition can be so easily and certainly cured"—The late Sir Harold Stiles.

Thomas G. Morton (1867) described with remarkable clarity the symptoms of that severe type of metatarsalgia which now bears his name: neuralgic pain felt in the sole about the fourth metatarso-phalangeal joint, radiation of pain to the fourth and sometimes the third toe, onset of pain with walking or standing, and relief of pain by resting with the shoe discarded. There can be little doubt that Morton's syndrome is the same as that which was discussed by Tubby and Sir Robert Jones, and suffered by Sir Harold Stiles.

FIG. 1
(Adapted from Spalteholz.) To show the relationship of the plantar digital nerves to the flexor brevis digitorum and lumbrical muscles and tendons.

Until recently the pathology of this condition has remained obscure, largely because surgeons have been loath to explore the cutaneous nerves of the sole for the reason that they feared the possibility of painful scars. In 1940, the late L. O. Betts of Adelaide reported a series of nineteen patients in each of whom the plantar digital nerve to the cleft between the third and fourth toes had been exposed through a longitudinal incision in the weight-bearing part of the sole. In every case a fibrous swelling of the nerve was found proximal to its point of division and adherent to the transverse metatarsal ligament. In every case resection gave relief from the neuralgic pain. In no case did trouble arise from the scar.

The findings of Betts have given great stimulus to the surgical treatment of Morton's metatarsalgia. He was too modest to claim originality, but his work appears to have been entirely independent. On a visit to England in 1939 he made extensive inquiries among orthopaedic surgeons, but found none familiar with these gross nerve changes. It is a matter for regret that his untimely death came before the value of his work was appreciated fully.

In this article evidence will be presented which gives general support to the conclusions of Betts, but indicates that the primary lesion is one of local vascular degeneration leading to a wide variety of changes in and around the cutaneous nerve. The observations of Betts, and still more of the author, could not have been made without free access through the sole of the foot.

APPLIED ANATOMY

Cutaneous nerves—The cutaneous branches of the internal and external plantar nerves appear in the sole of the foot on each side of the flexor brevis digitorum muscle (Fig. 1). The digital nerves for the three lateral clefts run an oblique course between that muscle or its tendons, and the plantar fascia, before gaining the spaces between the heads of the metatarsal bones. The important 3–4 cleft is generally credited with a dual supply through a main branch from the internal plantar nerve and a small communicating branch from the external plantar nerve. *Such a communicating branch is frequently absent.* When present, it may equal in size the main branch, with which it fuses just above the transverse metatarsal ligament. The nerve, either single or combined, is less than 2 mm. in calibre; it is close but not adherent to the ligament. In this region it lies in the bottom of a shallow trough, of which the sides are the stout common flexor sheaths and the floor the transverse ligament. Superficially the nerve is well protected by the lobulated fat of the sole, interspersed at one level with scattered fibres of plantar fascia. Just beyond the ligament the nerve divides to supply the adjacent sides of the third and fourth toes. Here it may be exposed with ease through a dorsal incision in the web space. The dissected foot shows that *there is no danger of nipping, and no danger of pressure against bone, in any part of the course of the main nerves to the three lateral clefts.* We have been able to confirm this fact by taking antero-posterior radiographs with fine wires laid alongside the nerves.

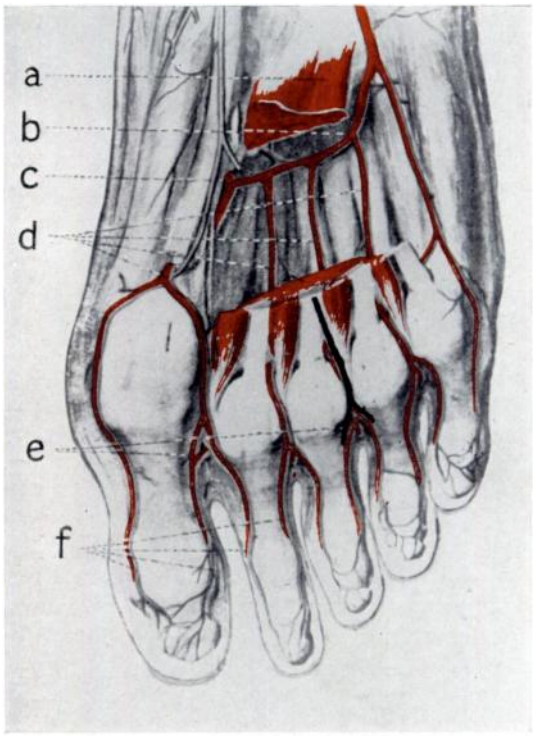


FIG. 2

(Adapted from Spalteholz.) To show the origin and course of the third plantar digital artery with its relation to the fourth plantar digital nerve. (*a*) adductor obliquus hallucis muscle, (*b*) deep plantar arch, (*c*) perforating branch of dorsalis pedis artery, (*d*) plantar digital arteries, (*e*) anterior perforating arteries, (*f*) collateral digital arteries. Adductor transversus hallucis muscle is shown deep to the common flexor tendons and lumbricals.

Blood supply to the 3-4 cleft—The third plantar digital artery is the main vessel of the region (Fig. 2). It arises from the deep plantar arch, and runs forward between the interossei and the adductor hallucis muscle. It rapidly becomes superficial round the distal margin of the transverse head of the latter muscle and appears to emerge from a tunnel in the upper border of the transverse ligament. The proximal margin of the tunnel, however, is no more than an oblique slip of fascia from the sheath for the flexors of the third toe. The vascular bundle approaches the digital nerve obliquely from the medial side, and runs between nerve and ligament. Just beyond the point of division of the nerve it also divides, and may be seen to receive the small anterior perforating artery from the dorsum. An important variation of this pattern occurs when the origin of the artery is from the neighbouring 2–3 interspace. It then has to cross the common flexor sheath for the third toe in order to reach the nerve, during which course it is particularly liable to pressure transmitted through the sole.

Other structures—The fibres of the *lumbrical muscle* to the fourth toe almost reach the transverse ligament, over which the fine tendon runs in intimate contact. The distal margin of the *adductor transversus hallucis muscle* is seen when the digital artery is traced upwards by dividing the oblique slip of fascia mentioned above. The large *inter-metatarso-phalangeal bursa* lies deep to the transverse ligament and seldom contains any free synovial fluid. The *fat*, as elsewhere in the sole, is arranged in well-defined lobules, often sufficiently distinct to feel on palpation like soft tumours. This lobulation is exaggerated when the metatarsal heads are prominent in the sole.

HISTORICAL REVIEW

Morton (1876) considered that the symptoms arose from compression of branches of the external plantar nerve to the outer side of the fourth toe, between the head of the fifth and the neck of the fourth metatarsal bone. He treated cases successfully by free excision of the fourth metatarso-phalangeal joint.

Writing in 1897 Sir Robert Jones used the term " plantar neuralgia " and described three degrees, the last of which corresponds with Morton's cases. " The third or severe variety comprises those cases where symptoms appear idiopathically or remotely after injury, are persistent in character, do not yield to mechanical measures, and to all effect cripple the patient." Sir Robert advanced the theory of direct pressure on the plantar digital nerves between the sole and the transverse metatarsal ligaments. He suspected organic changes and in a footnote records that Mr Tubby " operated on a case of advanced metatarsalgia and found the nerve swollen and congested." He advocated excision of a metatarsal head, usually the fourth, and advised against nerve resection because of the risk of a painful scar. In 1898, writing with Tubby, he considered that the communicating branch was subject to pressure against the head of the fourth metatarsal bone. There is some confusion as to the final views of Robert Jones because a diagrammatic dissection in " Orthopaedic Surgery " by Jones and Lovett (1929) shows the combined nerve itself running directly under the head of the same bone.

The practice of Tubby (1912) is well remembered by Sir Ernest Rock Carling. " He used to excise the head of the fourth metatarsal through a dorsal incision, and would always look for the plantar digital nerve, though often without success. On the occasions when it was seen the nerve was resected and it often showed more than one small nodule. Large swellings of the size described by Betts were not encountered. Tubby shared Sir Robert's distaste for plantar incisions and to my knowledge did not expose the nerve through the sole."

Over one period, theories of postural strain were popular. For example, D. J. Morton (1935) regarded the pain as referred from arthritis of the second tarso-metatarsal joint.

Since 1935, the colleagues of the late Sir Harold Stiles have been aware of fibrotic changes in the digital nerve. In a letter to me, written in 1943, Sir Harold described the onset twenty years previously of plantar neuralgia in his own left foot. " The symptoms began with the usual characteristic pain opposite the head of the third metatarsal. Ultimately the pain was so severe that I was obliged sometimes to quit in the middle of a round of golf. The next thing was that severe pain of a typical burning and causalgic nature became localised to a limited area on the adjacent sides of the terminal phalanges of the third and fourth toes." Sir Harold considered that the branch from the internal plantar nerve crossed obliquely under the head of the third metatarsal and was therefore subject to undue pressure. In 1935 he invited Mr Norman Dott to explore the nerves to the 3–4 cleft. Fibrosis of the epineurium of the branch from the internal plantar nerve was found, but the incision was not allowed to encroach on the ball of the foot and no actual enlargement was encountered. Free resection gave complete relief and the short incision in the sole healed soundly.

Sir Robert Jones' opinions were widely accepted until Betts published his series of cases in 1940. It is surprising that the gross nerve changes he described had not been discovered many years earlier.* There is no doubt that some surgeons have encountered painful fibrous nodules on cutaneous nerves of the sole, but without realising that similar changes were to be expected regularly in Morton's metatarsalgia. Others have known of the relief gained by nerve resection without recommending it strongly (Treves *et al.*, 1937). In the United States of America, McElvenny (1943), writing four years after Betts' first case, reported a similar series.

Microscopic examination of Betts' specimens showed intense fibrosis with demyelination, but no special comment was made as to the condition of local blood vessels. His conception of the etiology was again a mechanical one. " The fourth nerve is formed by the internal plantar, with a communicating branch from the external plantar, each coming round from opposite sides of the belly of flexor brevis and crossing this obliquely before they unite. . . . When the foot is in action, the flexor brevis contracts, fixing the origin of the nerve, while dorsiflexion of the toes in walking stretches it around the unyielding transverse ligament. The neuritis probably arises in the first place from minor trauma. . . . Once the nerve is swollen from neuritis a vicious circle is set up and the daily irritation is sufficient to keep it up (as in late ulnar neuritis). . . . Pressure from the plantar aspect does not appear to be a factor." A weakness in this argument is the fact, of which Betts was aware, that the communicating branch is often absent. The lesion may also occur in the 2–3 and 4–5 interspaces.

A feature of the earlier literature on Morton's metatarsalgia is the frequency with which the anatomy of the sole is described inaccurately. This has been an important factor in the survival of theories of pressure by bones on the cutaneous nerves.

CLINICAL MATERIAL

Patients in this series with pain or disability severe enough to warrant operation numbered twenty-seven. They fall into two separate and differing groups: eleven of a fairly standard pattern seen in 1942–43, and sixteen showing much greater variety seen in 1946–47. The contrasts between the two groups, and the main conclusions drawn from each, may be mentioned briefly before analysing the features of the total number.

Cases with long history—The 1942–43 group were seen after a longer duration of symptoms, the shortest times before operation being eight and twelve months, compared with one and two months in the second group. Easily visible changes were found so regularly in the digital nerve to the 3–4 cleft that had a nerve been found of normal calibre this would almost have been regarded as disproving the diagnosis. The enlarged nerves quite overshadowed the digital arteries which were often so degenerate as to be hardly recognisable. However, serial sections of a number of specimens established the degree, extent, and constancy of the vascular degeneration and suggested strongly that changes in the nerve were secondary and ischaemic in character.

Cases with short history—The 1946–47 group included four cases explored within two months of the onset of pain. Specimens from these cases have shown that degenerative changes start first in the digital artery and are followed by various degrees of connective tissue proliferation in and round the nerve. Again, there have been more atypical cases with structural abnormalities such as hallux valgus and anterior flat foot.

Of the whole series of twenty-seven cases, twenty-one were women and six men. At the time of operation the two youngest patients were aged twenty-three years, and the two eldest

* Bickel and Dockerty (1946) point out that Hoadley in 1893 resected a small neuroma on the digital branch of the external plantar nerve to the fourth toe and obtained " a prompt and perfect cure."

were aged fifty-three years and fifty-five years. The condition was bilateral in eight cases. The number of feet explored has therefore been thirty-five, of which twenty-one were right and fourteen left. The shortest duration of symptoms was one month. In this case pain was referred to the 2–3 interspace, but the lesion was found in the 3–4 cleft as usual. The longest duration was twenty-six years. This patient remembered vividly that she had been unable to participate in games from the age of eight, because of severe pain in the fourth toe. As a young woman she had repeatedly asked her doctor to amputate the toe. Resection of the nerve at the age of thirty-four gave complete relief. The next earliest age of onset was fourteen years. In no case was there a history of injury or strain at the time of onset more definite than walking on a rough road, or infantry exercises in deep snow.

Distribution of pain—Acute pain was almost entirely limited to two contiguous areas, the sole beyond the necks of the third and fourth metatarsal bones, and the entire surface of the corresponding toes (Fig. 3).

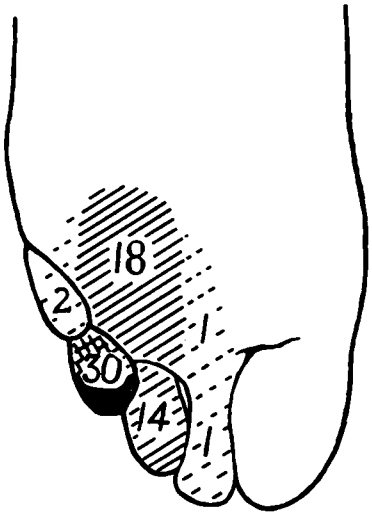


FIG. 3

Diagram to show the distribution of pain in thirty-three feet each with a proved lesion in the 3–4 interspace.

In twenty-two feet, pain was felt both in the sole and in a toe or toes.

In nine feet, pain was confined to the fourth toe, commonly to the nail-bed and the tip.

In only four feet, was pain confined to the sole.

Not only was pain seldom absent from the toes, but the most acute cases were those in which it was confined to the fourth toe. The word "metatarsalgia," and the term employed by Sir Robert Jones, "plantar neuralgia of third degree," do not indicate the frequency with which the pain is digital.

Characteristics of the pain—The pain was typically neuralgic. Most women complained of pain soon after walking on hard surfaces, especially in high-heeled shoes. One could control her pain completely by wearing open sandals, and if it had not been for the rigours of the English winter she would not have sought treatment. Relief was generally obtained by resting with the shoe removed. In severe cases, however, whether early or late, pain sometimes continued through the night with much loss of sleep. A number of patients had accepted profound alteration in their mode of life in order that the pain might be avoided; several had given up all recreations and took care never to walk more than half a mile at a stretch.

PHYSICAL EXAMINATION

Most patients had feet of normal form. Recently several have been seen with the combination of hallux valgus and anterior flat foot, but they have insisted that acute pain was an entirely new development, situated *distal* to the old-standing callosities. Apart from a few patients, seen during an acute attack who were suffering exquisite tenderness, physical signs were difficult to elicit. The most constant sign was pain on firm upward and backward pressure in the sole just distal to the third and fourth metatarso-phalangeal joints.

Swelling—Only one patient had a palpable swelling. This patient, who was shown at the Royal Society of Medicine in 1946, had actual separation of the third and fourth toes

(Fig. 4) and when standing there was a visible round swelling on the dorsum of each foot. It must of course be recognised that normal lobulation of the fat of the sole may stimulate a small local tumour.

Anaesthesia—Diminished sensation to pinprick in the cleft between the third and fourth toes was occasionally found. In a patient who may be accepted as a good witness, this is the most valuable of all signs. Nevertheless, even when there is gross fibrosis of the cutaneous nerve, sensation often appears normal, possibly because there is "take over" from adjacent normal nerves. For the same reason post-operative anaesthesia between the toes rapidly disappears.

Special radiographic examinations—X-ray films were taken in most patients, but with the exception of the one case mentioned above they were negative. The blood sedimentation rate was sometimes determined in order to exclude early rheumatoid arthritis. Special examinations such as the quinizarin sweat test (Guttmann 1947) and the tourniquet test for ischaemic pain (Schecter *et al.* 1945) have not been used.

FIG. 4

X-ray film to show separation of the third and fourth metatarsals and toes (bilateral case). The connective tissue mass round each nerve was roughly spherical and almost an inch in diameter. The soft tissue shadow can be seen in the web space.

OPERATIVE TECHNIQUE

Free exposure through a longitudinal plantar incision under general anaesthesia has been the routine (Fig. 5). An Esmarch bandage is fixed round the thigh and the patient turned into the prone position with the ankle resting over a sandbag at the end of the table. The third and fourth metatarsophalangeal joints are palpated, and an incision two inches or more in length is made between them, down to the web.* The incision is deepened, keeping between the common flexor sheaths. When the connective tissue round the nerve is great, it bulges freely into the wound. Usually, however, the nerve has to be sought where it crosses the transverse ligament. (From the practical aspect, if the surgeon is satisfied that the nerve

FIG. 5

Photograph at operation, with a blunt hook round the nerve and a dissector beneath the vascular bundle (specimen shown in Fig. 6*a*). An early case, with severe pain for two months. There was arterial degeneration but no definite "neuroma."

* A transverse incision in the tread has some advantages, especially when a neighbouring cleft may have to be explored.

is thickened and adherent to the ligament it is sufficient to resect it in this region without further ado.) The nerve is traced proximally to see how far the changes extend and whether a communicating branch is present. Distally the branches to each toe are defined. The digital artery is found deep to the nerve and traced upwards and medially to determine its source of origin. The whole nerve and vascular bundle are then removed. When there is reason for doing so, one or other of the neighbouring digital nerves may be explored through the same incision. There is no need to tie any vessels. The wound edges are accurately sewn with a blanket stitch. If early ambulation is necessary, a plaster shoe with a generous sponge-rubber heel may be applied over the dressings. When the specimen is to be preserved it should be mounted before fixation in order to avoid distortion.

After-care—Neuralgic pain disappears within a few days. The stitches are removed after ten days. If the scar needs protection, dry gauze fixed by elastoplast is used. Full weight-bearing is allowed only after fourteen days. Hot and cold contrast baths, with exercises for the foot and leg, are used at home for a further fortnight in order to control post-operative swelling and stiffness.

The scar—Sound scars, free from pain, have been the rule. Slightly tender thickening of either end of the scar may persist for a few months, but the weight-bearing part in the tread seems to " iron out " rapidly. Indeed, if a short plantar incision is to be used, it should be confined to the tread. This experience is in agreement with that of Gaenslen's " split heel " incision for osteomyelitis of the oscalcis. A dorsal incision in the web has not been used, mainly because such exposure affords limited access to the nerves and vessels.*

Post-operative anaesthesia—Sensation to pinprick usually returns within a few weeks to adjacent sides of the toes, but a narrow strip of anaesthesia on each side of the scar may persist for several years. Along the margins of the anaesthetic strip hyperaesthesia to light stimuli, such as the putting on of a sock or drying the feet, may also persist. As a matter of interest, Sir Harold Stiles, after submitting to proximal resection of the nerve, complained of hyperaesthesia in the tread distal to his small scar to a degree much greater than any patient in this series. In other words minor post-operative discomfort in the sole has been due more to cutaneous denervation than to the scar itself. Thus, there may be some point in limiting the length of nerve which is resected.

FOLLOW-UP REVIEW OF CASES

Of the earlier group of eleven patients, nine have been examined four years after operation. They gained complete relief, although one developed recurrence of pain in the 2–3 cleft a month before re-examination; excision of the corresponding nerve has again given relief (Fig. 6*c*). Of the two patients not re-examined, one, an infantry officer, resumed full training six weeks after operation and remained free from pain until he was killed in action two years later. The other, at that time an able seaman, has written to say that his feet are still painful. In his case the digital arteries were anomalous; they arose from the neighbouring 2–3 clefts, and it may well be that continued symptoms are arising from this cleft.

Of the second group of sixteen patients,* all have been examined at least three months after operation. Fifteen have complete relief of pain, and only one, a factory cleaner of low mentality, has incomplete relief. One patient, a psychiatrist, had coincident gout which responded to medical treatment. Another, from whom a spherical mass of connective tissue round the nerve almost one inch in diameter was removed from each foot (Fig. 4), has recurrence of the swellings and a further exploration may be advisable when permitted by her general condition and the pernicious anaemia from which she also suffers.

* Baker (1944, 1947), who finds that a dorsal incision is satisfactory, maintains that the digital nerve is *dorsal* to the transverse ligament in 25 per cent. of cases. This is incorrect: the nerve is on the plantar aspect of the ligament.

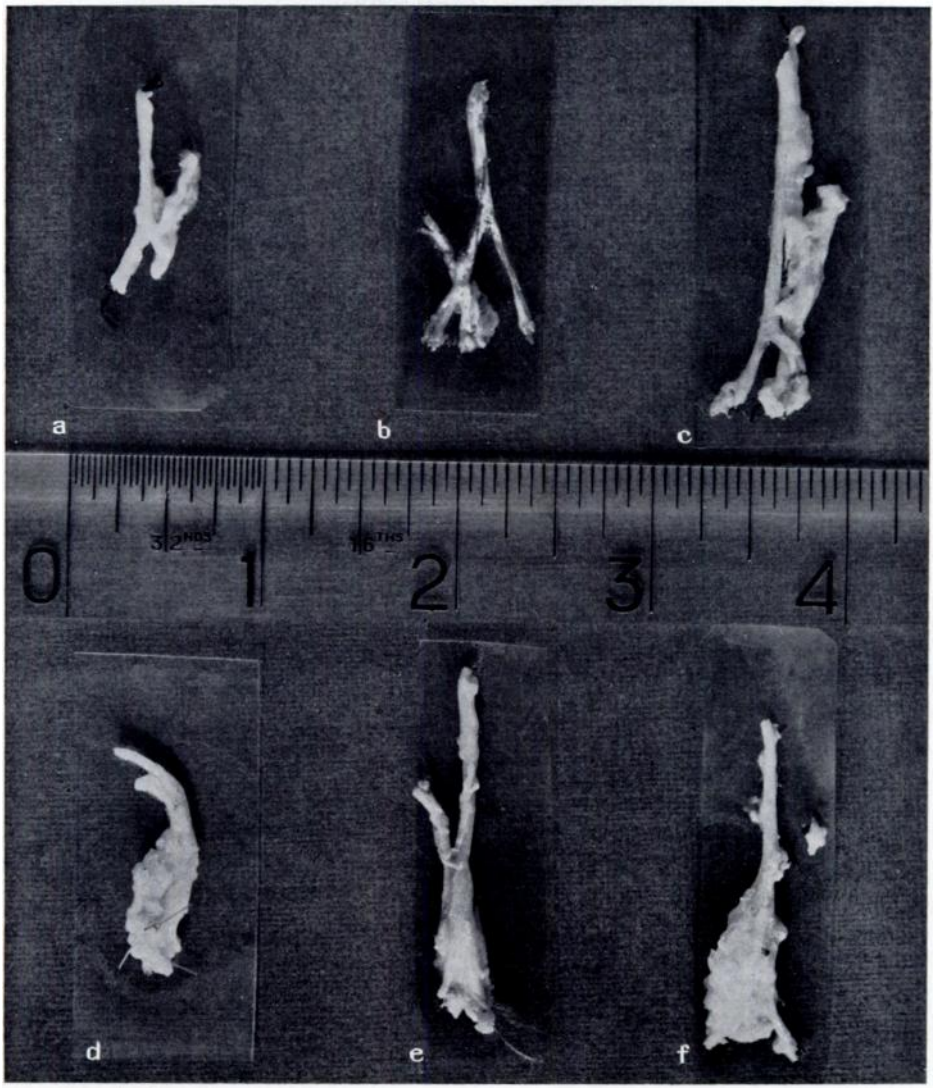


FIG. 6

Series of specimens to show the development of visible changes in the artery and nerve. Except for (*d*) the specimens are mounted as seen in situ.

(*a*) Tortuous and slightly thickened artery passing deep to branch of nerve to third toe. (*History—pain for two months, diffuse, but worst in third toe.*)

(*b*) Unusually high branching of nerve. Artery running deep to swollen nerve to third toe, and then involved in connective tissue. (*History—acute pain for one month only, extending to second and third toes. Structures in* 2–3 *cleft found normal.*)

(*c*) Specimen from 2–3 cleft. Artery surrounded by connective tissue and passing deep to nerve to second toe. Nerve thickened above level of transverse ligament. (*History—in* 1942, *pain fourth right toe for eight months.* 3–4 *cleft explored and a large "capsule" found enclosing an asymmetrical lesion affecting fibres to fourth toe. In* 1947, *acute pain in second and third toes of same foot; above specimen removed.* 1–2 *cleft also explored and found normal*).

(*d*) Unmounted specimen, side view, showing a short degenerated artery, with mass of connective tissue deep to fusiform swelling of the nerve. (*History—Pain for one year, radiating from sole to third and fourth nail-beds.*)

(*e*) Similar specimen mounted. Small nodules on proximal length of nerve. (*History—Pain for six years, felt in the sole and fourth toe.*)

(*f*) Typical asymmetrical lesion with connective tissue surrounding the nerve and branch to fourth toe. The degenerated artery has been cut. The fibrous enlargement of the nerve was much smaller but also asymmetrical. (*History—Pain for two years, only at tip of fourth toe.*)

MORBID ANATOMY

Inspection of the specimens, arranged roughly in order of duration of symptoms, shows a series of changes involving first the digital artery and later the digital nerve (Fig. 6).

The digital artery—The artery shows changes varying from thickening of the wall, with some proliferation of periarterial connective tissues and slight adhesion to the transverse ligament, up to gross degeneration so that the vessel is represented by an adherent fibrous strand with no lumen. The proximal limit of degeneration has not been determined because the artery has not been excised farther than the proximal margin of the transverse ligament.

The digital nerve—With advancing arterial changes the digital nerve develops a firm fibrous swelling which shows a variety of patterns:

1. A fusiform swelling just above the point of division of the nerve.
2. An asymmetrical swelling at the same site affecting mainly the fibres to the fourth toe (this lesion is associated with marked localisation of pain to the fourth toe).
3. A lesion of either of these types with one or more nodules situated proximally up to the point of junction with the nerve to the 2–3 cleft.
4. Rarely, thickening of the branch to the third toe only.

Connective tissue proliferation—Proliferation of loose connective tissue round the nerve may be so great as to suggest a term such as "capsule." Primarily this tissue is periarterial. There is no evidence to suggest that any of it is derived from the walls of the intermetatarso-phalangeal bursa (Hertzler, 1926). The following patterns have been seen (Fig. 6):

1. Minimal proliferation round the digital artery alone.
2. Small masses of diffuse connective tissue deep or lateral to the nerve.
3. A mass beginning to envelop the nerve from its deep surface.
4. A larger mass completely ensheathing the nerve and the origin of its branches.
5. A gross mass palpable and visible as a soft tumour in the web space (Fig. 4).

Such findings occurred thirty-three times in the 3–4 space, once in the 2–3 space, and once in the 4–5 space.

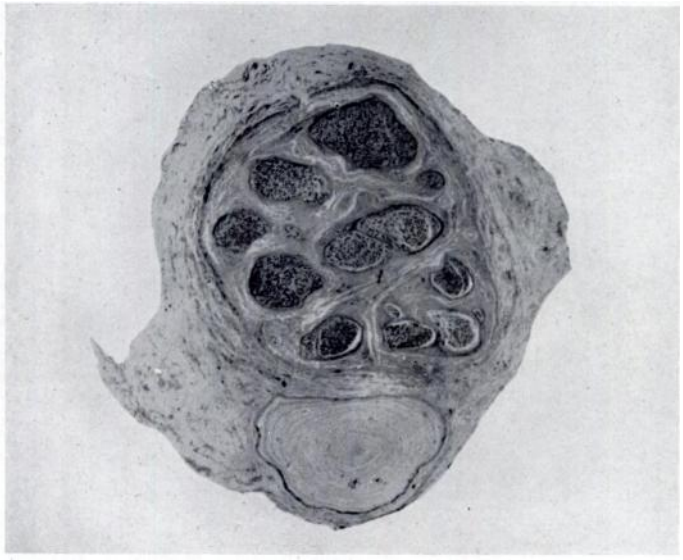
Histological examination—Microscopic examination of a number of specimens from the 1942–43 group has been carried out by Mr William Holmes. He considers that the nerve lesion is ischaemic. The histology of specimens showing early changes has not yet been completed, so that no more than brief reference will be made to the main features seen in the fully developed condition (Fig. 7). A marked increase of epineurial connective tissue provides the main bulk of the fibrous swelling. Degeneration of the nerve fibres is variable in degree, with pathological changes in the bundles of an unusual type. The digital artery shows severe degenerative changes—disruption of the arterial wall, thrombosis, and incomplete recanalisation. The intraneural vessels show changes which appear secondary to those in the main vessel, and which no doubt extend to the capillary bed.

Anatomists and neuro-surgeons agree that within the larger peripheral nerves the longitudinal vascular channels are so intimately linked from level to level that the loss of one local vessel, for example by ligation, has little effect on the efficiency of the blood supply (Adams, 1942, 1943). This arrangement accounts for the rarity of ischaemic lesions of nerve. On the other hand Professor Durward believes that it is important to appreciate that thrombosis of an adjacent artery might induce profound effects by extension to the intraneural vessels themselves. He agreed with Holmes that there was evidence of such a process in a number of typical slides referred to him.

Holmes points out that digital nerves in general are accompanied by vessels proportionately much larger, and hence of greater importance, than those running with the main nerve trunks. In a series of hand injuries, for instance, he found convincing evidence of ischaemic changes in many digital nerves resected prior to grafting. Large nodules similar to those found in Morton's metatarsalgia may occur on the median and ulnar nerves in

certain late cases of Volkmann's contracture where the nerve lesions are undoubtedly secondary to the ischaemia (Holmes *et al.* 1944).

So far no reason has been found why the digital vessels of the 3–4 interspace are particularly subject to degeneration. Anatomically they are related to the transverse ligament



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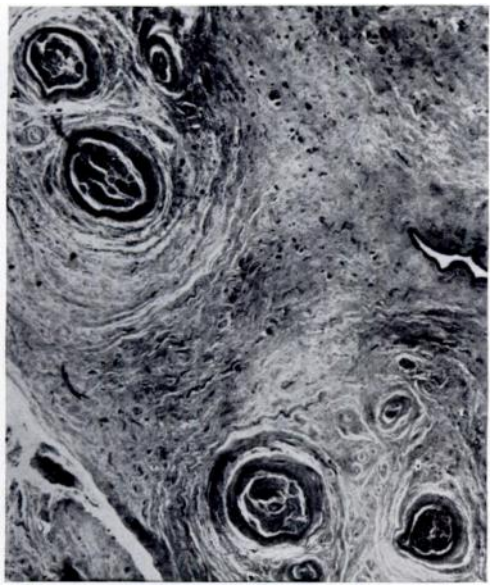

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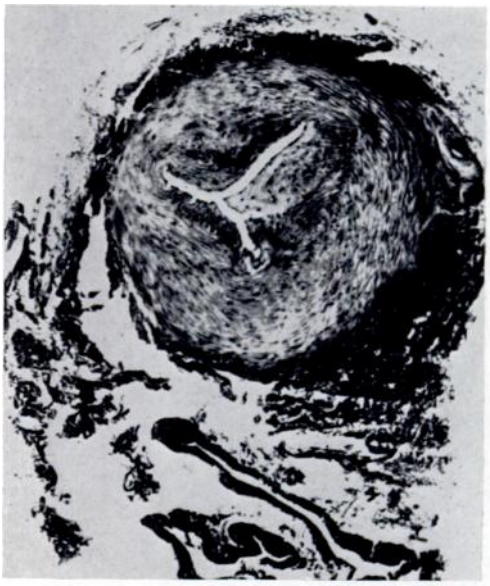

(*c*)

FIG. 7

Cross-sections of a typical lesion.

(*a*) Nerve just above a fusiform swelling, showing minor changes (X25).
(*b*) Middle of fusiform swelling, with marked increase of connective tissue around and between the nerve bundles (X25).
(*c*) The vascular bundle, with the arterial changes well shown (X50).

more intimately than the digital nerve and occasionally, when derived from the 2–3 interspace, they have first to cross the ridge of the common flexor sheath for the third toe. The most likely factor would seem to be repeated minor trauma to the digital artery from pressure transmitted through the sole.

SUMMARY AND CONCLUSIONS

1. A series of cases of Morton's metatarsalgia is reported in which twenty-seven selected patients have had thirty-five operations on the sole of the foot.

2. At operation, degeneration of the plantar digital artery to the cleft between the third and fourth toes has now been found to precede the fibrous thickening of the nerve described by Betts in 1940. Similar changes rarely occur in neighbouring clefts.

3. Local resection of the nerve almost always gives complete relief from pain, and the plantar scar gives rise to no trouble.

4. Histological findings show that the nerve lesion is ischaemic in nature.

5. Acute pain arising as a new event in cases of the deformity of " anterior flat foot " may prove to be due to this condition.

6. Morton's metatarsalgia is a distinct clinical and pathological entity which can best be described as a plantar digital neuritis.

Acknowledgments. My especial thanks are due to Mr William Holmes for the histological work, and to Professor Archibald Durward for his opinions on a number of the sections. Eight patients were kindly referred by Mr D. Lloyd Griffiths, Mr H. Osmond Clarke, Mr H. Jackson Burrows, Mr A. T. Fripp, Mr V. H. Ellis, and Mr Eric Lloyd. Miss Joan H. Tabor of the Kodak Research Laboratory prepared the photomicrographs and Mr R. J. Whitley of the Institute of Orthopaedics carried out the other photographic work with great care.

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