

that resection on the right side for all types of operation was three times as lethal as on the left side. We felt the marked difference between the two sides was due solely to the relative volumes of the two lungs and to the subsequent effects of mediastinal displacement on the heart and remaining lung after right-sided resection.

Accepting the need for conservative resection, the problem at operation is how little lung can be removed and yet give a hope of a five-year cure?

Provided the anatomical situation of the tumour makes lobectomy a reasonable operation, the decision between performing a total or a subtotal operation must depend on nodal involvement as assessed at the time of operation. The upper lobe tumours present less of a problem than lower lobe lesions in that those with mediastinal nodal involvement have already metastasized and pneumonectomy will be no more radical a procedure than lobectomy. Study of 21 patients who had upper lobectomy and died of metastases showed that with two exceptions all were dead within two years—that is, within the period when nodal metastases usually affect prognosis. There is no reason to believe that these would have survived any longer after pneumonectomy even if they survived the major operation.

Lower lobe tumours are more difficult, especially on the left side, where we found 50% with nodal involvement compared with 25% on the right. Of the patients dying of metastases after lower and middle lobectomies, 22 had tumours in the lower lobes and four in the middle lobe. All the latter died within 12 months, and with two exceptions all those who had lower lobectomies were dead within 23 months. They thus survived about the same length of time as the patients after upper lobectomy. It is conceivable that right pneumonectomy might save a few more patients with lower lobe tumours, but, in view of Rouvière's (1932) work on lymphatic drainage from the left lower lobe, it is doubtful whether left pneumonectomy would have eliminated metastases, particularly if the subcarinal nodes were involved. It would be good fortune if no cancer cells had passed through to the right side by the time the node showed involvement.

We found, despite the reduction in the duration of symptoms, that the two-year survival rate has remained constant, about 45%, and concluded that this was due to increasing nodal involvement, particularly by squamous tumours. The proportion of lobectomies performed since 1951 (except 1953) has been over 40%, and the fact that the two-year rate has remained steady despite an annual increase of nodal involvement suggests that adequate gland removal has been obtained with the less extensive operation in most cases. We feel, therefore, that when the site of tumour and nodal involvement permits of lobectomy this operation is preferable because it preserves lung function and usually provides an adequate removal of the tumour and attendant lymph nodes.

Summary

The fate of 2,156 patients suffering from bronchial carcinoma admitted to the Liverpool Thoracic Surgical Unit has been studied and related to the known cases registered by the Cancer Control Organization.

714 patients were explored and 464 tumours resected; 448 patients were followed to death or survival for a minimum of one year.

347 survived the arbitrary operative phase and 45% and 28% survived for two and five years respectively.

The cause of operative deaths has been analysed and 62.37% found to be due to "cardio-pulmonary failure."

Right-sided operations were more lethal than left, especially for pneumonectomy, and more so when deaths were due to cardio-pulmonary failure.

The quinquennial age group 55 to 59 years made up 24% of all survivors; they had the lowest mortality after

pneumonectomy and had the best two-year and five-year survival rates of 53% and 45% respectively.

Patients with growths in the right lower lobes had the earliest symptoms, the lowest incidence of nodal involvement, and the best five-year survival rate for both squamous and undifferentiated tumours.

Left lower lobe tumours had the highest nodal involvement and the highest proportion of undifferentiated tumours, but the survival rate was similar to the left upper lobe.

Adenocarcinoma appeared to be the most malignant type of tumour, though nodal involvement was no higher than with undifferentiated types.

Despite earlier operation in relation to symptoms, the two-year survival rate has hardly changed, probably owing to the increasing incidence of nodal metastases.

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COMPRESSION OF MEDIAN NERVE IN CARPAL TUNNEL AND ITS RELATION TO ACROPARAESTHESIAE

BY

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The purpose of this paper, which is based on a study of 53 patients with acroparaesthesiae, is to present information concerning the diagnosis, prognosis, and treatment of this condition and to discuss its underlying mechanism.

Schultze (1893) introduced the term "acroparaesthesiae" to describe nocturnal attacks of pain and paraesthesiae that affect the hands of middle-aged women. Wilson (1913) reported the syndrome, often with partial thenar atrophy and objective sensory loss over the digits, in association with cervical rib. Walshe (1945), however, stated that muscular wasting does not occur and the objective sensory loss is exceptional, though when the pain and paraesthesiae are maximal there may be some blunting of cutaneous sensibility over the digits. The most constant feature was, he considered, tenderness over the extensor muscles of the fore-

arm and sometimes over the thenar and adductor muscles of the thumb. He concluded: ". . . that traction and compression of the lower trunk of the brachial plexus and possibly also of the subclavian artery are the essential mechanical factors underlying most, if perhaps not all, cases of acroparaesthesia in women, that these factors are caused by sagging of the shoulder girdle, and this, in turn, is a natural consequence of an atonic supporting musculature." More recently, Walshe (1951) reaffirmed this contention and discussed the importance of structural and functional abnormalities of the thoracic inlet.

Brain, Wright, and Wilkinson (1947) described the cases of six women, three of whom had acroparaesthesiae, with signs indicative of a lesion affecting the median nerve in the carpal tunnel. At operation they were found to have swelling of the median nerve proximal to the transverse carpal ligament, and in some, where it lay beneath this structure, there was evidence of direct compression of the nerve. Relief of symptoms and improvement of the neurological deficit followed a decompressive operation. McArdle (1951) was the first to suggest that this mechanism was responsible for the production of acroparaesthesiae, and Kremer, Gilliatt, Golding, and Wilson (1953) reported the complete relief of all symptoms in 37 out of 40 cases submitted to surgery; re-exploration of the three who did not obtain benefit showed that the transverse carpal ligament had not been fully divided in two, whilst the last had a cyst attached to the flexor tendons within the carpal tunnel. Gilliatt and Wilson (1953) provided further evidence of a median-nerve lesion in their patients by the study of ischaemic paraesthesiae and sensory fading. Occlusion of the brachial artery was effected by a pneumatic cuff inflated to above arterial pressure. Patients with acroparaesthesiae developed intense tingling in the median distribution within 30 to 60 seconds, and if ischaemia was maintained a number were found to have cutaneous sensory loss in the same territory within 10 minutes.

In spite of this work Ford (1956) writes of acroparaesthesiae: "The fact that there is never any evidence of nerve root damage, even after symptoms have been present for many years, seems to be very strong evidence against the possibility that the symptoms are neurogenic." He preferred to call the condition the "tired arm syndrome," and suggested that it arose from an accumulation of metabolites in fatigued muscle.

Material and Methods

Patients were accepted for the present series who complained of attacks, lasting from minutes to hours, in which they experienced various combinations of pain and paraesthesiae in the digits and palm of one or both hands. Radiation of pain to the forearm and arm was recognized as a variant of the syndrome. Some patients had no objective neurological deficit, others had motor and sensory signs distal to the wrist. The finding of any other neurological abnormality, such as an alteration in the state of the deep tendon reflexes, necessitated rejection from the series.

Fifty-three patients fulfilled these requirements, and between the years 1949 and 1956 inclusive were diagnosed consecutively as suffering from acroparaesthesiae or compression of the median nerve in the carpal tunnel. Of these, 38 attended the department of neurology in the General Infirmary at Leeds, and 15 were seen in private consultant practice by one of us (H. G.).

Details of the treatment and the follow-up are described below. In addition to the routine questioning and exami-

nation, ischaemic sensory tests were carried out on eight patients before treatment and on 43 during the course of the follow-up. A pneumatic cuff was wrapped round the arm and inflated to a pressure of 220 mm. Hg, which was in all instances above arterial pressure. The patient was asked to describe any sensory symptoms affecting the digits or hand that might follow this procedure during the next two minutes. In the greater number the occlusion of the brachial artery was maintained for up to 10 minutes, and sensation over the volar surface of the digits and palm was tested with a pin at two-minute intervals. At the end of this time, if no abnormality was detected, two-point discrimination was tested over the tips of the digits before the cuff was released.

Clinical Features

The number of cases diagnosed in each year is shown in Table I. It can be seen that the annual incidence has steadily increased since 1953. The 53 patients (46 women and 7 men) were between the ages of 18 and 76. In about

TABLE I.—Number of Examples of Acroparaesthesiae Diagnosed Each Year

1949	1950	1951	1952	1953	1954	1955	1956, First Nine Months
1	2	0	2	5	8	18	17

a half of them symptoms began during the fifth and sixth decades, and there was a second, but smaller, peak in the age distribution between the 25th and 30th years. Possible predisposing factors included the following.

Occupational Stress.—Thirty-eight of the women patients, who were either housewives or were engaged in domestic work, related the onset of symptoms to a period of increased activity. Many had noticed improvement after a holiday and had relapsed when they resumed their duties. Tasks which were especially prone to provoke symptoms included heavy lifting, polishing, washing, and knitting. Four men first made complaint after a change of work to a postman, wirewinder, gardener, and pneumatic driller respectively.

Trauma.—In three patients the onset occurred immediately after a fall upon the outstretched hand; one sustained a Colles fracture, one a posterior dislocation of the lower third of the ulna, whilst the last had no bony injury. Another had lacerated her wrist by pushing it through a window.

Arthropathy of Wrist.—Radiographs of the wrist were taken in eight cases and were normal in four. A gross osteoarthropathy of the wrist-joints affected three elderly patients, which was most marked on the side of the neurological symptoms; one other had extensive rheumatoid arthritis of the hands.

Pregnancy.—Symptoms came on during pregnancy for the first time in one patient and a relapse ensued in another.

Symptoms

The duration of symptoms was from six weeks to fifteen years. The right hand was first affected in 34 patients, and with one exception all were right-handed persons; in 18 the condition became bilateral within a matter of months. Symptoms began in the left hand in 10 and in five remained unilateral; four patients were left-handed, two sustained an injury to the left wrist, and one held a pneumatic drill in the left hand. In nine both sides were affected simultaneously.

Method of Presentation.—In 45 cases the first intimation that anything was wrong came as a nocturnal attack of either pain, paraesthesiae, or both, referred to the digits and palm. Most often this awakened the patient in the small hours of the morning, and lasted for 10 to 30 minutes. With the passage of time these episodes became more frequent and more severe until there was a more or less continuous background of discomfort throughout the day. In the other eight cases the symptoms began

insidiously and were both persistent and steadily progressive, though punctuated at intervals by diurnal and nocturnal attacks similar to those described.

Pain.—Thirty-six patients complained of pain in the digits and a greater or lesser portion of the adjacent palm. The little finger was involved in only three, all of whom were poor witnesses of fact. In the remainder the distribution was the first four digits (16), the first three digits (13), the first two digits (1), the index and middle fingers (2), and the index, middle, and ring fingers with sparing of the thumb (1). The pain was described as "bursting" or "burning," and it radiated centripetally in 13 to involve the forearm and in six the arm. The seven who had digital paraesthesiae without pain complained of dull ache in the forearm and arm.

Paraesthesiae.—Forty-one patients complained of a disagreeable "pricking" or "tingling" sensation and 22 of "numbness" in the digits. Eight of these did not have digital pain, but when pain and paraesthesiae occurred together the site of reference was, with minor variations, the same and always within the distribution of the median nerve.

Other Complaints.—Ten patients, all of whom had suffered for more than six months, complained of slight weakness of the hand, and three of these had noticed wasting of the thenar eminence. Five others stated that during the height of an attack their fingers turned "white," and another had noticed excessive sweating of the median two-thirds of the hand.

Physical Signs

In eight patients the hands were objectively normal. Careful examination in the remainder revealed a slight-to-moderate neurological deficit, and when symptoms were bilateral there was seldom any major difference between the physical signs on the two sides.

Motor System.—Eighteen patients had wasting of the thenar muscles. Fasciculation was not seen, nor was there any tenderness of muscles of the thenar eminence, forearm, or arm. The scapular muscles were normal and drooping of the shoulder-girdles was not evident. Relative weakness of the abductor pollicis brevis was detected in 36, and opposition of the thumb, as judged by internal rotation of the first digit, seemed to be defective in many.

Sensory System.—A slight alteration of cutaneous sensibility was found in 29; this consisted of relative hypalgesia, hypaesthesia, and impairment of two-point discrimination in 21, while 7 stated that a pin-prick felt abnormally sharp. Delimitation of minimal sensory change over the palm was often difficult owing to the thickness of the skin, but the incidence with which various digits were affected is shown in Table II. It will be seen that in all cases the abnormality was within the cutaneous distribution of the median nerve.

TABLE II.—Frequency and Distribution of Cutaneous Sensory Impairment

Designation of Affected Digit					No. of Patients
1	2	3	4	5	
1	1	1	1	0	3
1	1	1	1	0	18
1	1	1	0	0	6
0	0	1	1	0	2

Special Investigations

Electromyography.—In six patients electrical examination was made of the first dorsal interosseous, thenar, and hypothenar muscles and extensor muscles of the fingers and forearm. In two the findings were normal, in four there were changes indicative of denervation of muscles supplied by the median nerve below the wrist.

Compression of Wrist.—Digital pressure was applied to the volar aspect of the wrist over the transverse carpal ligament in five patients and was maintained for three minutes. This manoeuvre provoked an attack of acroparaesthesiae in three and in two was without effect.

Occlusion of Brachial Artery.—The methods of studying ischaemic paraesthesiae and sensory fading have already been described. Six out of eight patients tested in this way developed intense paraesthesiae, and, of this number, four exhibited cutaneous sensory impairment within the distribution of the median nerve.

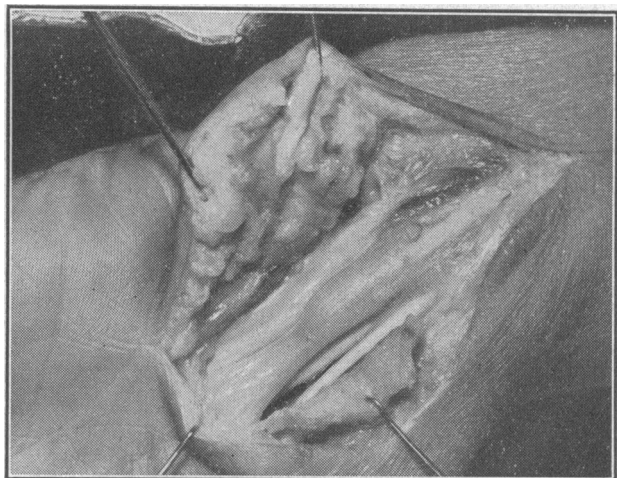
Radiographs of Cervical Spine.—Plain radiographs of the cervical spine were taken in six patients, and were normal in five. One was found to have bilateral cervical ribs.

Treatment

Most of the earlier patients were advised to have surgical treatment, and 53 operations were done on 35 patients. One of these had been submitted previously to a two-stage removal of bilateral cervical ribs, from which she had obtained no benefit.

Operative Technique.—Under a general anaesthetic the transverse carpal ligament was exposed through an incision passing along the longitudinal palmar crease at the base of the thumb and up to the transverse crease in front of the wrist to the region of the pisiform bone. This gave a palmar flap large enough to expose the transverse carpal ligament, which was approached through a small longitudinal incision through the palmar fascia in the midline and divided. In some patients the skin incision was extended proximally along the ulnar border of the forearm in order to inspect the median nerve at this site.

Operative Observations.—No abnormality was seen at 29 operations, but at 20 the median nerve was swollen to about twice its normal diameter for between 1 and 3 inches (2.5 and 7.5 cm.) proximal to the transverse carpal ligament; after division of this structure the swelling subsided within a few minutes. In nine of these, and in two where the nerve was not swollen, the median nerve was flattened over that portion of its length where it lay behind and adjacent to the transverse carpal ligament; distal to this ligament the normal convexity of the nerve reappeared (see Figure). In



Compression of the median nerve in the carpal tunnel. The anterior carpal ligament has been divided, showing constriction of the median nerve beneath the ligament with swelling of the nerve proximal to the point of compression. (By kind permission of Sir Reginald Watson-Jones, who performed the operation at the London Hospital. Photographed by R. F. Ruddick.)

eight operations this abnormality persisted, but in three the nerve regained its normal rounded appearance by the end of the procedure. All of these patients had suffered from symptoms for more than six months, many for several years, and all had a moderate neurological deficit. One case requires further description.

Case 1.—In September, 1950, a woman aged 47 had sustained a laceration to the volar surface of the right wrist which had severed some of the flexor tendons and "nicked" the median nerve just above the annular ligament. Primary suture of the tendons and of the nerve was carried out, but in March, 1954,

the wound was re-explored on account of local pain, and a small lateral neuroma of the median nerve was excised. The results of this procedure were initially satisfactory, for power was preserved and the pain relieved, though there was some sensory loss over the territory of the median nerve in the hand. In October she began to have nocturnal attacks of burning pain and paraesthesiae in the median four digits of both hands, but worse on the right side. These became more severe and more frequent until November, 1954, when she was admitted to hospital. Both carpal tunnels were explored; on the left no abnormality was found, on the right silk sutures were removed from the median nerve, which appeared to be otherwise healthy.

Medical Treatment.—Eighteen patients were advised to rest the affected hand as much as possible and to avoid those tasks which were known from experience to provoke symptoms. No other treatment was given.

Results in Surgically Treated Cases

A follow-up of 33 of the 35 patients submitted to surgery had been carried out by one of us (J. P. P. B.) up to the time of writing. The intervals between operation and final assessment were from two months to seven years; 24 were followed up for more than six months, 13 for more than a year. Two patients were followed-up for only three months, and thereafter postal information was obtained from one, and one was untraced. Of the 18 patients who had bilateral operations, 10 obtained complete relief of all symptoms in both hands and three on one hand alone. The latter include one with slight weakness of a hand, one who has persistent aching pain in the forearm and arm, and one who complains of pain in the wrist (Case 1). Three patients, two of whom were elderly valetudinarians, have slight and intermittent tingling of two or more digits on both sides; the case of the third of these follows:

Case 2.—In December, 1955, a woman aged 52 experienced attacks of burning pain, tingling, and numbness affecting the median four digits of both hands which came on at night. In April, 1956, examination showed slight weakness of the abductor pollicis brevis and a minimal hypalgesia over the cutaneous sensory distribution of the median nerve on both sides. Both transverse carpal ligaments were divided and the patient became symptom-free for two months. Thereafter she developed tingling in the ulnar two digits of both hands and difficulty in walking. In September, 1956, examination showed painful restriction of all cervical movements, cutaneous sensory loss in the dermatomes C 8-T 1 on both sides, and a mild spastic paraplegia. A diagnosis was made of cervical root and cord compression from cervical spondylosis which was demonstrated on plain radiographs.

Of the 17 patients who had a single operation, 11 became symptom-free. The remainder enjoyed a great measure of improvement, but three complained of slight weakness of the hand, two experienced occasional and mild paraesthesiae of two or more digits, and one had pain in the region of the fifth metacarpal which came on after a fall.

With two exceptions, Cases 1 and 2, all were well satisfied with the result, all returned to a normal life, and none had more than minimal symptoms. Indeed, one who did not obtain complete relief of symptoms had returned to his work at the coal-face within seven weeks of an operation on his right wrist.

Before treatment 19 had sensory impairment; 29 had weakness, and of these 10 had wasting of the thenar eminence. After operation sensory loss was found in two and relative weakness in three, two of whom also had some wasting of the thenar eminence. No patient without physical signs before operation developed a neurological deficit after treatment. From the clinical aspect it remains to be said that about half complained of pain and swelling at the site of operation for a few weeks, but this was seldom troublesome and never persistent. Eight experienced aching or tingling in the scar which was precipitated by local pressure or by cold. Cheloid formation did not occur.

Ischaemic paraesthesiae were studied in 29 patients on both sides and the results were normal in 21. Eight, six of whom had been followed up for less than four months, complained of paraesthesiae in the territory of the median

nerve on one side within two minutes. Ischaemic sensory fading was tested in 22 of the above 29 on both limbs, and no abnormality was found in 19; two developed sensory loss in the median territory on the treated hand and one on the untreated hand within 10 minutes.

Results in Medically Treated Cases

A complete and personal follow-up was done on 17 of the 18 patients after intervals of one month to six years; 14 were followed for more than six months and 10 for more than a year. One other was followed for three months only, and since that time has remained untraced. One of the 18 had suffered from increasingly severe nocturnal attacks of acroparaesthesiae for two years and had obtained no benefit from rest; bilateral operations were done at another hospital, and since that time she has been symptom-free; she now has no objective deficit, and ischaemic sensory tests are normal.

Of eight patients who had bilateral symptoms, three have symptomatic relief, but any attempt to return to normal work or household duties results in a relapse, one has improved, and four continue to have nocturnal attacks three or four times a week. Of the nine who had unilateral symptoms, five are symptom-free so long as they avoid tasks which involve flexion and extension of the wrist; three continue to have nocturnal attacks of severe pain and tingling.

Of the eight with an initial sensory deficit, five regained normal sensation, but in three impairment of sensation appeared during the period of observation. Normal muscle bulk was restored in three out of seven who had partial thenar atrophy, but the wasting increased in four. Weakness of the abductor pollicis brevis improved in four out of seven but appeared for the first time in two others.

Ischaemic paraesthesiae were studied in both hands in 14 patients and the results were normal in six; paraesthesiae in the territory of the median nerve appeared in six on both sides and in two on one side within two minutes. Ischaemic sensory fading was studied in 10 of the above 14 patients on both sides; sensation in the territory of the median nerve became impaired in two on both sides and in six on one side within 10 minutes.

None of these patients were able to lead unrestricted lives and seven continued to suffer from frequent nocturnal attacks of pain and paraesthesiae.

Discussion and Conclusions

All the evidence obtained by the present analysis of 53 patients with acroparaesthesiae suggests that the underlying mechanism is compression of the median nerve in the carpal tunnel. The dominant symptoms of pain and paraesthesiae are almost invariably referred to the cutaneous territory of the median nerve, and, though there may be no objective neurological deficit, when such exists it provides additional support for this localization of the lesion. The centripetal radiation of pain is an observed but unexplained fact. When electromyography and ischaemic sensory tests are carried out there is additional support for the contention, and to this must be added the operative findings and the symptomatic relief which follows surgical treatment. For these reasons we cannot agree with Ford (1956) that acroparaesthesiae results from the accumulation of metabolites in fatigued muscle, nor yet with Walshe (1945, 1951) that the condition is determined by structural or functional abnormalities of the thoracic inlet. Indeed, it is notable that the one patient who had bilateral cervical ribs obtained no benefit from their removal, whilst she became free from all symptoms after surgical division of the transverse carpal ligaments.

Garland (1955) has remarked on the predominance of women in all series of median nerve palsy whilst in other peripheral nerve palsies the greater number are men. This may be related to the smaller size of the carpal tunnel in women and to occupational factors. Brain *et al.* (1947)

have shown that pressure within the carpal tunnel is greatest when the wrist is extended, and this posture is especially associated with such household tasks as polishing, knitting, and scrubbing; indeed, it is these activities that provoke symptoms in patients with acroparaesthesiae. The occasional onset or relapse in pregnancy may be aggravated by narrowing of the carpal tunnel by fluid retention. The mechanical nature of the malady is emphasized further by the frequency with which the dominant hand is first affected, and when this does not obtain other factors such as osteoarthropathy of the wrist, trauma, or the nature of employment may be incriminated. These contributory factors are especially common when men are affected.

When surgery is employed it is most inadvisable to adopt the straight longitudinal incision along the midline of the volar aspect of the forearm. This crosses the joint flexure at right angles and pays no attention to the tension lines in skin. Nearly all the patients are women, and it is a surgical solecism to inflict a scar which will in all likelihood produce a cheloid. It is also a cosmetic impropriety to place such a scar in a position which is readily visible. A skin incision has been described which gives an adequate exposure, leaves a featureless scar, and does not in any way interfere with the function of the wrist or hand.

Most often there are no abnormal findings at operation, but in about a third of the cases the median nerve is swollen for a few inches above the transverse carpal ligament and, since this is immediately reversible, is probably determined by oedema. Less frequently there is evidence of direct compression of the median nerve by the transverse carpal ligament, and it is likely that the flattening of the nerve is caused by the duration and extent of the compression.

An analysis of patients treated by surgery shows that there is invariable immediate and dramatic relief of symptoms and that this is maintained; there is then a diminution or disappearance of any pre-existent neurological deficit as judged by clinical examination and the results of ischaemic sensory test. All returned to normal activity. Minor disadvantages include pain and swelling of the volar aspect of the wrist and aching pain provoked by pressure on the scar or by cold. The former does not last for more than a few weeks, but, because it is at times troublesome, it is best to avoid operating on both sides for bilateral symptoms at the same time unless they are very severe. Two separate operations were done on a number of patients and, after the first, symptoms disappeared on the treated side alone. All of these returned of their own accord for the second operation and this seems sufficient answer to those who maintain that the rest enforced by surgery is responsible for the cure.

It must be admitted that rest by itself often gives relief from all symptoms and leads to the disappearance of a pre-existent neurological deficit. However, none who were treated in this way were able to lead unrestricted lives, and some, despite prolonged inactivity, obtained no benefit and developed a progressive objective disability. In addition, ischaemic sensory tests showed a persistent abnormality in the majority. We consider, therefore, that surgery provides the optimum treatment unless the history is short, the symptoms relatively mild, or the patient is able to afford the luxury of prolonged unemployment.

Summary

The clinical features of 53 cases of acroparaesthesiae are described; dominant symptoms consisting of pain and paraesthesiae are almost invariably referred to the territory of the median nerve in the hand, and in the majority there is a slight objective deficit compatible with a median nerve lesion at the wrist.

Electromyography and ischaemic sensory tests lend support for localization of the lesion at the wrist.

The great predominance of female patients may be explained by the smaller size of the carpal tunnel in

women and to occupational factors. In men the onset may be determined by osteoarthropathy of the wrist, trauma, or a change of employment.

Division of the transverse carpal ligament gives immediate and lasting relief of symptoms and improvement of any neurological deficit that may have existed.

In about one-third of the patients there is direct or indirect evidence of compression of the median nerve in the carpal tunnel at operation.

Rest may alone relieve symptoms, but relapse occurs in the majority of patients when they resume a normal life. Some achieve no improvement and develop a progressive neurological deficit.

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SICKLE-CELL-THALASSAEMIA DISEASE IN SOUTH TURKEY

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When both the genes controlling the formation of normal adult haemoglobin (haemoglobin A) are replaced by alleles responsible for the sickle-cell haemoglobin variant (haemoglobin S), sickle-cell anaemia (S.C.A.) results. If only one A gene is thus replaced, normally no disability results, the AS heterozygote being a symptomless carrier of the sickle-cell trait (S.C.T.) (Neel, 1947, 1949; Beet, 1949; Pauling *et al.*, 1949). The thalassaemia gene is not an allelomorph of those responsible for the formation of haemoglobin A and its variants, but its effect is a suppression of haemoglobin A formation. If an AA homozygote inherits two thalassaemia genes a severe anaemia results—thalassaemia major. If he is heterozygous for the thalassaemia gene the condition is very much less severe or even symptomless—thalassaemia minor (Gatto, 1942; Wintrobe, 1942; Dameshek, 1943; Valentine and Neel, 1944; Chini, 1946; Silvestroni and Bianco, 1946a).

If, however, an AS heterozygote inherits a single thalassaemia gene, suppression of haemoglobin A formation with a subsequent preponderance of haemoglobin S may produce a state which resembles S.C.A. This modified S.C.A. is called sickle-cell-thalassaemia disease (S.C.Th.D.) or microdrepanocytic disease (Silvestroni and Bianco, 1946b, 1952, 1955; Powell *et al.*, 1950; Gatto and Purrazzella, 1951; Wasserman *et al.*, 1952; Sturgeon *et al.*, 1952; Neel *et al.*, 1953; Humble *et al.*, 1954; Singer *et al.*, 1955; Edington and Lehmann, 1955).