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TREATMENT FOR TUBERCULOSIS OF THE SPINE

Anti-tuberculosis Drugs in Conjunction
with Radical Operation and Short Hospitalization with no
Enforced Recumbency or Immobilization

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MUNKSGAARD

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Preface

This investigation was carried out during the period 1958-60, when the author worked as Head of the Department of Orthopaedic Surgery at the 'National Medical Center in Korea', a hospital located in Seoul and operated jointly by the South Korean and Scandinavian Governments. The first patients were admitted in December 1958. It soon became clear that tuberculosis of bone and joints was a major orthopaedic problem and that there was an apparently unlimited number of patients in this field. The author's appointment was scheduled to terminate in the summer of 1960, and the present investigation was planned accordingly. Subsequently it became possible to extend the investigation so as to include a follow-up study of the patients investigated. This follow-up study was carried out in September-November 1961.

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Finally, the author would like to mention his particular pleasure in carrying out this investigation, since it was in this same field of medicine that his father, Nikolai Paus, M.D., worked for his doctor's thesis.

Introduction

The investigation which will be reported in this paper was confined to the problems associated with a certain method of treatment for tuberculosis of the spine. Problems of pathogenesis, pathology, diagnosis, etc., will not be discussed. It is sufficient to recall that the condition may be regarded as a spinal metastasis caused by systemic spread of tubercle bacilli, usually to the bodies of the vertebrae.

Until the introduction of effective anti-tuberculosis drugs, treatment for tuberculosis of the spine required enforced recumbency, immobilization and hospitalization for several years, preferably in specialized hospitals. This method will in the following be referred to as 'orthodox treatment'. A little more than a decade ago a form of treatment was introduced in which anti-tuberculosis drugs were used in conjunction with a direct, surgical attack on the lesion. Enforced recumbency, immobilization and long hospitalization have been required with this method of treatment also, although not to the same extent as with orthodox treatment. It might well be asked if these procedures could be abandoned in view of experiences in other areas of medicine. Thus ambulatory treatment with anti-tuberculosis drugs is now sometimes used for pulmonary tuberculosis. The reduction in post-operative recumbency and hospitalization after resections of the stomach, appendicectomies and herniectomies is also indicative, although no direct comparison can be made between tuberculosis of the spine and these conditions. In South Korea at the time of the present investigation this question was also of practical importance; patients with tuberculosis of the spine were numerous, while not one single specialized hospital for bone and joint tuberculosis existed in the country, and practically none of the patients could afford long hospitalization.

It was also felt that a unique opportunity existed to examine what could be achieved by modern medical methods in a country where little had so far been done to combat tuberculosis.

Review of Previous Literature on Tuberculosis of the Spine

The literature on the different methods of treatment will be reviewed in the following, both in order to assess the results obtained and to determine to what extent the problem posed in the introduction has been discussed by other workers. The review is divided into sections according to the type of treatment used: (1) orthodox treatment; (2) ambulatory treatment with anti-tuberculosis drugs; (3) radical operation; (4) literature on other aspects of tuberculosis of the spine with a particular bearing on the findings in the present investigation, and (5) summary of published data.

1. ORTHODOX TREATMENT

(a) *Treatment*

The orthodox treatment was entirely constitutional in its character and required recumbency, immobilization by means of plaster-beds, body casts or corsets, and hospitalization, preferably in specialized hospitals for bone and joint tuberculosis. There the patient could be exposed to fresh air and sunshine and receive adequate food. From 1911 onwards, the fusion operation of HIBBS or ALBEE was carried out in certain cases. According to THOMAS (1875), the rest required should be enforced, uninterrupted and prolonged, while KORNEW (1957, p. 599) stated that 'Immobilization must be precise, systematic and uninterrupted from beginning to end of the disease, bearing in mind that "2 minutes walk renders 48 hours recumbency null and void"'. The average period of time spent in hospital was reported by ALVIK (1949) to be thirteen to fourteen months for patients who were discharged only after the completion of treatment, but REINHARD (1960a) kept patients in hospital for as long as four to five years.

A more extensive survey of the literature on orthodox treatment can be found, e.g. in the monographs of ALVIK (1949) and FELLÄNDER (1954).

(b) *Results of treatment*

Clinical findings. On the basis of the total number of patients treated, 29.1–44.0 per cent were found to have full working capacity, while on the basis of the follow-up of surviving patients, the figures were 60.7–69.5 per cent. The figures for patients with partial or full working capacity, on the same basis, were 36.5–73.0 per cent and 80.0–87.3 per cent respectively (ALVIK 1949, FELLÄNDER 1954, KONDO & YAMADA 1957, BAKALIM 1960 and REINHARD 1960). The period of observation varied from twelve months to twenty-four years.

Subjective complaints in the form of pain, tiredness, weakness or stiffness in the back were reported in 14.7–73.4 per cent of the cases (ALVIK 1949, KONDO & YAMADA 1957 and BAKALIM 1960).

Complete recovery from paraplegia in 10 out of 23 cases was reported by ALVIK (1949), in 80 out of 141 cases by GRIFFITHS, SEDDON & ROAF (1956), and in 18 out of 31 children by KAPLAN (1959).

Radiological findings. Healing was reported in 35.0–88.0 per cent, and fusion in 48.09–52.5 per cent of these cases (ALVIK 1949, FELLÄNDER 1954, HALLOCK & JONES 1954 and BAKALIM 1960).

Interval between discharge or operation and resumption of work. An interval between discharge and resumption of work of up to six months was reported by ALVIK (1949) in 24.46 per cent, and up to one year in 58.16 per cent of 184 patients who were subsequently able to work and where this interval was known. BAKALIM (1960) found that the interval between the fusion operation and the resumption of work was less than one year in 101, and less than two years in 124 cases out of a total of 208 on whom the operation was performed, i.e. a proportion of about 50.0 and 60.0 per cent respectively.

Kyphosis could develop or increase while the patient was being treated in a plaster-bed, and the fusion operation had little or no effect in preventing its development, at least with dorsal lesions (ALVIK 1949, HALLOCK & JONES 1954, BAKALIM 1960, ROAF 1960 and INGELRANS 1961). Moderate or very large kyphosis was reported by BIERRING (1934) in eight out of 17 children and 10 out of 59 adults, most of whom were followed up eight to eleven-and-a-half years after the Albee fusion operation. ALVIK (1949) found the same degree of kyphosis in 20.51 per cent of 273 patients observed for at least two years, while KAPLAN (1959) found severe and gross kyphosis in 45 out of 96 children where four or more vertebral bodies were affected. HALLOCK & JONES (1954) found an increase in radiological kyphosis of 10° or more in 31 out of 79 lesions in patients followed up five to twenty-two years after fusion

operation, mostly in children and in dorsal spine; BAKALIM (1960) reported a similar increase in 11 out of 59 lesions after fusion operation.

Mortality has been reported to vary from 9.5–53.0 per cent (ALVIK 1949, FELLÄNDER 1954, KONDO & YAMADA 1957 and BAKALIM 1960).

(c) *Orthodox treatment with the addition of anti-tuberculosis drugs*

The value of using anti-tuberculosis drugs in conjunction with orthodox treatment is not clear. Some reduction in treatment time may be achieved, but not to any marked extent, as stated by HALD (1952), JONES (1953), DAUBENSPECK & RAUSCH (1955) and KAPLAN (1959). On the other hand, no reduction in treatment time was found by WILKINSON (1954) or MUKOPADHAYA (1956). KAPLAN (1959) reported a higher recovery rate of paraplegia, 83.0 per cent out of 29 children, than by recumbency alone, 58.0 per cent of 31 children. The effect on the spinal affection is uncertain, occasional and impossible to predict (WILKINSON 1954, MUKOPADHAYA 1956, STEVENSON 1957, WASSERFALLEN 1957, BAKALIM 1960 and DEBEYRE 1961). Recently, however, STEVENSON & MANNING (1962) reported that 66 out of 71 patients lived a normal active life, 93.0 per cent; bony fusion occurred in 41 cases, 56.1 per cent. No reduction in the interval between fusion operation and the resumption of work was found, BAKALIM (1960); severe and gross kyphosis was reported by KAPLAN (1959) in 26 out of 101 children with four or more vertebrae affected. The drugs were found to be most effective when used in conjunction with direct operation (HALD 1952, WILKINSON 1954, KATAYAMA, ITAMI, ÖYA, TANAKI & MARUMO 1955 and KONDO & YAMADA 1957).

2. AMBULATORY TREATMENT WITH ANTI-TUBERCULOSIS DRUGS

This method was tried by MUKOPADHAYA (1956), KONSTAM & KONSTAM (1958) and KONSTAM & BLESOVSKY (1962); patients were allowed to be up and about, usually at home. The last two authors reported that 100 out of 307 patients failed to complete treatment. The remaining 207 patients attended for nine months or more; the authors were able to hospitalize only those suffering from paraplegia to such an extent that they had difficulty in walking, and those patients with pointing abscesses. Incision of the abscess or costectomy was carried out on 33 such patients. The average hospitalization was three weeks. No operation was performed on the remaining 174 patients. Clinical healing was reported in 178 patients, 86.0 per cent,

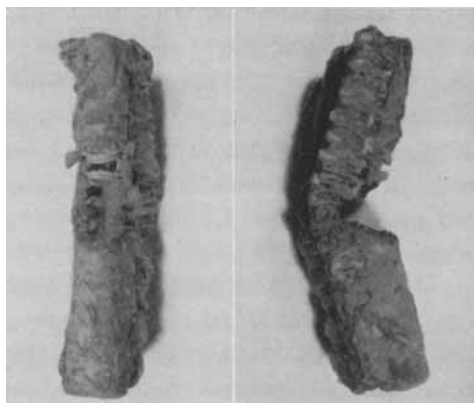
and fusion in 153 patients, 74.0 per cent. The interval between the beginning of treatment and the resumption of work was less than twelve months in 109 cases, 59.0 per cent. Recovery from paraplegia was seen in 26 out of 28 cases in which surgery was not used and in 25 out of 28 cases after costectomy. The kyphosis increased by 11° or more in 77 cases—as assessed from their histogram—out of the total of 207 patients, 37.2 per cent.

3. RADICAL OPERATION

The term 'radical operation' has often been used to indicate a direct surgical attack on the spinal lesion including evacuation of abscesses and curettage of the lesion. The term is somewhat misleading, since eradication, meaning complete elimination of all the diseased material, cannot be effected (Fig. 1). However, because of the wide acceptance of this term, it will nevertheless be used in the following text.

Figure 1. *Specimen of spine after radical operation*

A 5-year-old boy was admitted to another department because of some other disease but died shortly after admission. His tuberculosis of the spine was 'operated' in the usual way, but post mortem, and this specimen was then removed. Macroscopic granulation tissue and bone sand, both in small amounts, and remnants of a disc were found in the specimen at the site of the lesion



The operation was reported by TREVES (1884), KRAUSE (1889), MÉNARD (1900), MÜLLER (1906), ITO, TSUSHIYA & ASAMI (1934) and GJESSING (1951). There were many good, isolated results. Complications were, however, frequent and serious, and the operation was advised against by SCHMIEDEN (1930). The teaching outlook was aptly expressed by CALOT (1930, p. 223) as follows: 'The surgeon who, so far as tuberculosis is concerned, swears to remove the evil from the very root, will only find one result waiting him – the death of his patient'. After the anti-tuberculosis drugs became available, radical operation was once more introduced in a combined method of treatment.

(a) *History*

WILKINSON (1949), HALD (1950), ORELL (1951, 1951 a and b), KASTERT (1951, 1951 a), KONDO & YAMADA (1951) were the first to report the treatment with anti-tuberculosis drugs in conjunction with direct surgical attack on the spinal lesion. For detailed information on the history of this combined method of treatment, the reader is referred to EHRLACHER (1952) and STEVENSON (1957).

(b) *Indications and contra-indications*

A variety of opinions has been expressed by various authors in regard to the indications for the use of this combined method of treatment. Thus HALD (1952, p. 88) advocated that it 'should be employed more often than has been done so far'. FELLÄNDER (1954), KASTERT (1957), BOULVIN (1960) and DEBEYRE (1961) performed the operation with little regard to factors such as the age of the patient and the stage or extent of the disease, while STEVENSON (1957) and REINHARD (1960 a) evaluated each case individually. HODGSON & STOCK (1960 a) operated on selected cases of florid disease. GUICHAUX (1960) operated only after first having tried conservative treatment, while DAUBENSPECK & RAUSCH (1955) and GUERIN (1961) found that the indications were very limited. BAKALIM & LANGENSKIÖLD (1960) found the operation practicable in only 10.0 per cent of their cases, WEBER, BERLEMONT & HIRTZMANN (1961) found the operation indicated only for diagnostic purposes in uncertain cases, and a most unfavourable view was expressed by PERKINS (1961, p. 119): 'Excision ... is not practical when the area is unapproachable as in disease of the spine'.

In children, WILKINSON (1955), MUKOPADHAYA (1956), and STEVENSON (1957 a) found the indications to be wider than in adults, and SERAFINOVA & MALAWSKI (1959) operated on all cases, but REINHARD (1960 a) was reserved in his opinions. FERRAND (1961) operated only after having first tried prolonged medical treatment, while DELAHAYE, JACOB & TREPS (1961) felt that the operation was unnecessary in young children.

The divergence in the views expressed at a symposium in Paris, 1961, was summarized by DEBEYRE (1961 b) to the effect that some surgeons operated in every case, but others were content to use drugs alone.

Differences of opinion exist also as to the contra-indications. Thus MAY (1954), HALL & ADAMSON (1956), MUKOPADHAYA (1956), KONDO & YAMADA (1957) and RISKÓ & NOVOSZEL (1963) would not operate in the early stage of the disease, while DAUBENSPECK & RAUSCH (1955), BAKALIM & LANGENSKIÖLD (1960) and HODGSON, STOCK, FANG & ONG

(1960) hesitated to operate in advanced, extensive cases. KASTERT (1957), BAKALIM & LANGENSKIÖLD (1960), HODGSON & STOCK (1960), REINHARD (1960 a) and MARCONI, BOMBELLI & MIRABELLA (1960) regarded pulmonary tuberculosis as a possible or complete contra-indication for the operation.

(c) *Treatment*

The *medication* used was isoniazid (INH), para-aminosalicylic acid (PAS) and streptomycin (SM), either all together or in various two-drug combinations. The period of pre-operative medication varied from eight days (KASTERT 1957 and BOULVIN 1960) to three months (WILKINSON 1959, KATAYAMA 1961 and DEBEYRE 1961). Such pre-operative medication was sometimes waived by FELLÄNDER (1957) and DEBEYRE (1961). The period of post-operative medication varied from three months (FELLÄNDER 1957) to eighteen to twenty-four months (BAKALIM & LANGENSKIÖLD 1960 and HODGSON & STOCK 1960 a). At the Paris symposium in 1961 the conclusion was reached by DEBEYRE (1961 b) that the usual period of medication was twelve to eighteen months.

Operation. All authors agree on the main principle: to open the abscess and remove the diseased material of the spinal lesion; but they have different and sometimes controversial opinions on details of technique and in regard to additional procedures.

The importance of additional, constitutional treatment was emphasized by WILKINSON (1949-61) more than by anyone else. Flushing of the wound with saline solution and deposition of SM before closure was used by ORELL (1951-56); a posterior fusion operation was usually done but not always, or preferably an anterior, intercorporeal fusion by the use of bone grafts in the bone cavity. Anterior fusion operation was routinely carried out by HODGSON & STOCK (1956, 1960). Local, post-operative instillation of anti-tuberculosis drugs through a tube for six weeks was emphatically advocated by KASTERT (1951-60). Packing the wound with gauze for twelve to fourteen days and letting it close by secondary healing was the procedure used by DEROY & FISHER (1952). Filling of the bone cavity with a mass of plaster and SM was used by FRÜND (1951).

A posterior fusion operation was used by GRUCA (1957), RISKÓ & NOVOSZEL (1959, 1963) and DELAHAYA *et al.* (1961). Either anterior or posterior fusion was used by SERAFINOVA & MALAWSKI (1959). The bone cavity was packed with grafts in special cases by KONDO & YAMADA (1951-61), EHRLACHER (1954, 1956), HALD (1955) and MUKO-

PADHAYA (1956); some of these authors found this appropriate in cases with small cavities only, while others used the procedure only in cases with large cavities. The cavity was filled with grafts more routinely by CAUCHOIX, MÉCHÉLANY, TERSEN, MOREL & COTREL (1961). The destroyed vertebral body was replaced by a bone block from the upper part of the tibia or by a complete vertebral body from a bone bank by EHRLACHER (1954) and FERRAND & BARSOTTI (1961). Panarthrodesis with both anterior and posterior fusion operation was advocated by HALL & ADAMSON (1956), BAKALIM & LANGENSKIÖLD (1960), CAUCHOIX *et al.* (1961) and GRUCA & SERAFIN (1961).

Packing the lesion with bone grafts and posterior fusion operation were, on the other hand, considered unnecessary or undesirable by DEROY & FISHER (1952), FELLÄNDER (1957), KASTERT (1957 a and b), BOULVIN (1960), SCHEPEL (1960) and DEBEYRE (1961).

The period of post-operative, local instillation of drugs was shortened by SCHEPEL (1960) and DEBEYRE (1961) to two and three weeks respectively. MUKOPADHAYA (1956) and BOULVIN (1960) used daily instillations instead of continuous drip, for three weeks and thirty-five to sixty days respectively.

The operative approach differed with the surgeon and with the location of the lesion. It is mentioned that MACRAE (1957) used a bilateral costotransversectomy, and REINHARD (1960 a) operated on lesions in L 1-4 in two stages, first emptying the lesion from behind and later removing abscesses from the front.

The method of dealing with abscesses varied from the complete removal of the abscess wall to mere opening and evacuation. The removal of diseased material was usually completed by curettage of the spinal lesion. However, in children, KARLÉN (1959) removed only the necrotic material which presented itself spontaneously and avoided curettage.

Post-operative recumbency and hospitalization. There has been no typical duration of the post-operative recumbency. DEROY & FISHER (1961) allowed their patients to get up a few days after operation. Periods of two months have been reported, FELLÄNDER (1954) and KATAYAMA (1961), as well as eight to twelve months, REINHARD (1960 a). Most authors reported that postoperative recumbency lasted from three to eight months.

Hospitalization lasted from four to six months in most instances, but here again there have been wide variations. Thus MUKOPADHAYA (1956) was forced by circumstances to reduce hospitalization to six to seven weeks. FELLÄNDER (1957) reported that hospitalization was less

than three months in 53.0 per cent of his cases. On the other hand, a period of eighteen months, or not much less than after orthodox treatment and fusion operation, was reported by BRUNNER (1954), REINHARD (1960 a) and DEBEYRE (1961 c).

Immobilization by the use of plaster-beds, body casts and corsets has been generally effected, and over a longer period of time than that spent in the recumbent position or in hospital. Thus MUKOPADHAYA (1956) immobilized his patients for six to eight months but hospitalized them for only six to seven weeks, while REINHARD (1960 a) immobilized patients for three years but hospitalized them for eighteen months. On the other hand, FELLÄNDER (1954) abandoned the use of plaster-beds for patients who had previously undergone the fusion operation. KATAYAMA (1961) gradually gave up their use, but continued to use corsets for six months after the patient had got up. DEBEYRE (1961 c) gave up almost completely the use of both plaster-beds and corsets, and DERROY & FISHER (1952, 1961) gradually stopped all use of immobilization.

(d) *Results of treatment*

Clinical findings. Complete restoration of working capacity was reported by various authors in 53.3–95.7 per cent of patients, and complete and partial working capacity in 68.0–95.7 per cent (Table 1). BOULVIN (1960) followed up 65 patients out of a group of 103, and found both clinical and radiological healing in 61 of them.

Slight complaints were reported by FELLÄNDER (1954) in 11 out of 100 patients, 11.0 per cent, by BAKALIM & LANGENSKIÖLD (1960) in at least eight out of 18 patients, and by KONDO (1961) in 29 out of 90 patients, 32.3 per cent.

Recovery from paraplegia was reported by KASTERT (1957) in 11 out of 19 cases, by HODGSON & STOCK (1960) in 26 out of 35, by CAUCHOIX *et al.* (1961) in 12 out of 22, and by RISKÓ & NOVOSZEL (1963) in 10 out of 10 cases.

Radiological findings. Healing was reported by various authors in 52.0–94.0 per cent of the cases (Table 2), and bony fusion was found in 38.0–94.0 per cent when complete and incomplete fusion were considered together. MUKOPADHAYA (1956) was apparently unable to follow up all his patients but, of 56 thus followed, all were found to have healed. KASTERT (1957) reported fusion in 96.2 per cent of about 1,000 patients, but he failed to differentiate between bony and fibrotic fusion. DERROY & FISHER (1961), in just over 100 patients who had been observed for as long as ten to twelve years, found that 'these

TABLE 1. *Working capacity after treatment with anti-tuberculosis drugs in conjunction with radical operation for tuberculosis of the spine*

Authors	Patients	Observation period	Working capacity			
			Complete		Complete and partial	
	Number	Years	Number	Per cent	Number	Per cent
Felländer (1954)	100	1-4	62	62.0	68	68.0
Serafinova & Malawski (1959)	389	—	—	—	—	80.0
Bakalim & Langenskiöld (1960)	18	2-10	12	—	13	—
Cauchoix (1961)	204	—	180	88.4	—	—
Debeyre & Derrion (1961)	263	1-7	—	—	—	94.0
Kastert (1961)	app. 1,500	—	—	—	—	90.0
Kondo (1961)	90	1-9	48	53.3	76	84.6
Wilkinson (1961)	138	— 10	132	95.7	—	≥ 95.7
Riskó & Novoszel (1963)	105	—	—	—	89	84.7

TABLE 2. *Radiological findings after treatment with anti-tuberculosis drugs in conjunction with radical operation for tuberculosis of the spine*

Authors	Patients or lesions	Observation period	Radiological findings	
			Healing	Fusion
	Number	Years	Per cent	Per cent
Felländer (1954)	100	1-4	52.0	42.0
Wilkinson (1957)	84	—7	—	53.6
Wilkinson (1959)	130	1-10	92.3	—
Riskó & Novoszel (1959)	103	2-5	—	57.0
Bakalim & Langenskiöld (1960)	18	2-10	—	55.0
Hodgson & Stock (1960)	100	2-4	—	94.0*
Hodgson (1961)	300	—	—	78.7*
Cauchoix <i>et al.</i> (1961)	204	—	—	84.5
Debeyre (1961)	100	4-7	94.0	38.0
Riskó & Novoszel (1963)	105	—	—	60.0

* The difference in the findings is due to the extension of the operation to cases which were less suitable for anterior fusion, *Hodgson* (1963).

individuals remain perfectly stable and almost invariably will go on to spontaneous fusion'.

Interval between operation and resumption of work. The following intervals have been given by FELLÄNDER (1954):

<i>Interval (months)</i>	<i>Number of patients</i>	<i>Cumulative total</i>
2-6	13	13
6-9	19	32
9-12	11	43
12-24	19	62
More than 24	2	64

WILKINSON (1957) reported a period of twelve to fourteen months, and CAUCHOIX *et al.* (1961) a period of sixteen months.

Kyphosis was mentioned by WILKINSON (1953), who performed an anterior fusion operation on two children because of progressive deformity; the deformity continued to increase in one of these children. CAUCHOIX *et al.* (1961) found that kyphosis increased in 25.0 per cent of their patients. They concluded that anterior fusion operation could prevent kyphosis only in early cases or in old cases which either were stable or had been stabilized by means of posterior fusion, the operation for which should preferably be carried out three months prior to that for anterior fusion. Unfortunately, they gave no information on the age of their patients. RISKÓ & NOVOSZEL (1963) found that anterior fusion operation did not prevent an increase in kyphosis when three or four or more vertebrae had been destroyed.

Mortality. The operative mortality reported by various authors was 0.0-9.9 per cent (FELLÄNDER 1954, KASTERT 1957, WILKINSON 1959, BOULVIN 1960, HODGSON *et al.* 1960 and REINHARD 1960 a).

4. OTHER ASPECTS OF TUBERCULOSIS OF THE SPINE

The papers on other aspects of tuberculosis of the spine which are reviewed here will be restricted to a few which have some relevance to the present investigation.

The correct *diagnosis* of tuberculosis of the spine is of obvious importance in any study of treatment methods. It is therefore of interest that the same clinical and radiological features may be encountered in chronic pyogenic spondylitis (ALVIK 1951), and in other

diseases of the spine, as in tuberculosis of the spine. Thus the diagnosis can be confirmed only by the demonstration of tubercle bacilli in the lesion (JOHNSON, HILLMAN & SOUTHWICK 1953). However, DEBEYRE (1961) demonstrated that, in patients who had taken anti-tuberculosis drugs before operation, bacilli were found less frequently the longer the period of pre-operative medication.

Failure to demonstrate the histological changes characteristic of tuberculosis does not necessarily exclude the disease; NISSEN-LIE (1941) reported such a failure in cases in which tubercle bacilli were found. The chances of finding such histological changes are reduced in patients who have taken anti-tuberculosis drugs (WILKINSON 1954, KASTERT 1954, REINHARD 1960 a, MAZABRAUD 1961, DEBEYRE 1961).

Various systems of *classification* of tuberculosis of the spine have been proposed. Division into seven groups was suggested by *Hellstadius* (1937) as follows: (1) paradiscal spondylitis; (2) spondylitis with disc reduction; (3) spondylitis with extensive destruction; (4) central spondylitis; (5) vesicular spondylitis; (6) surface spondylitis with anterior, posterior or lateral localization; (7) spondylitis with diffuse osteoplastic changes. ALVIK (1949) proposed a division into the following four groups: (1) paradiscal spondylitis; (2) central spondylitis; (3) surface spondylitis; (4) spondylitis primarily localized to the arch or processes. FELLÄNDER (1954) simply divided cases of the disease into those with or without abscess formation, since he believed that classification according to the localization was of little practical value.

A diagnosis of *abscess* may be made on a radiograph in cases where no abscess is found by operation (HALD 1952, FELLÄNDER 1954, HODGSON & STOCK 1960 and RISKÓ & NOVOSZEL 1963). This is probably because a reactive inflammation produces soft tissue swelling. In cases with a dorsal spinal lesion, a pointed paravertebral abscess shadow indicates penetration to the lung (HODGSON & STOCK 1960).

Osteosclerosis and growing exostoses are, according to SCHEEL (1939, 1939 a, 1944), signs of activity rather than of healing.

Resistance of tubercle bacilli to anti-tuberculosis drugs has been reported to be unusual in tuberculosis of the spine (HALD 1952, FELLÄNDER 1954, KASTERT 1957, KONDO & YAMADA 1957). A warning has been given by FREERKSEN (1957) against over-estimating the problem of drug resistance in patients suffering from the disease. On the other hand, with the increase in resistant strains of tubercle bacilli in recent years, it would appear that these views must be treated with some reserve (HODGSON 1963).

5. SUMMARY

A review of the relevant literature shows that enforced recumbency, immobilization and hospitalization for thirteen months to five years, and preferably in specialized hospitals, were the essential features of the orthodox treatment for tuberculosis of the spine. These procedures appear to continue to be required even if anti-tuberculosis drugs are added. They are also routinely required in treatment with anti-tuberculosis drugs in conjunction with radical operation, although the period of post-operative recumbency is then generally reduced to three to eight months, and hospitalization to four to six months. Immobilization usually lasts somewhat longer than hospitalization.

A study of the relevant literature also brings out that widely differing and even controversial views exist concerning the actual method of treatment by anti-tuberculosis drugs in conjunction with radical operation. This concerns particularly the indications for operation, contra-indications, duration of medication, operative technique, necessity for and duration of recumbency and immobilization, and length of time to be spent in hospital.

Objectives and Plan of the Investigation

The foregoing review of the literature shows that no report was found on a planned study of the problem raised in the introduction, namely:

- (i) *can enforced recumbency, immobilization and long hospitalization, preferably in a specialized hospital, be omitted in the treatment for tuberculosis of the spine by anti-tuberculosis drugs in conjunction with radical operation?*

The main objective of the present investigation was therefore to examine whether such a treatment was practicable and justified, at least in a country with conditions like those prevailing in South Korea at the time. If the findings should be in the affirmative, a further objective would be to study:

- (ii) *what effect on prognosis could be ascribed to the various relevant factors?*

The investigation was planned to include studies in which a group of patients would be treated with anti-tuberculosis drugs in conjunction with radical operation; this group is referred to in the subsequent text as group A. The drugs would be restricted to INH and PAS as long as the patients remained outside the hospital; SM would be added only while the patients were in the hospital. The purpose of this procedure was to ensure that the treatment would be as uniform as possible. The daily doses used were standardized in proportion to body weight; the duration of the pre-operative medication period would depend on uncontrollable factors, including the varying waiting time before admission to the hospital and possible medication before the first consultation at the hospital. This would, however, permit a study of the possible effect on prognosis of the variation of this medication period. The post-operative medication period was planned to last from twelve to eighteen months.

The operation was to be carried out as soon as possible after the diagnosis had been made and would aim at as complete elimination of the diseased material as possible. SM would be left in the wound which would be closed primarily. Bone grafting in the cavity, fusion operation and local post-operative instillation of anti-tuberculosis drugs would not be used.

Recumbency would not be enforced or even encouraged, but patients would be allowed to get up as soon and as much as they liked; immobilization would be replaced by active exercises. The treatment would be carried out in a general hospital; hospitalization was planned to last from four to six weeks. This was believed to permit the completion of all the necessary pre-operative examinations and a post-operative hospital stay similar to that for other types of surgery of the same magnitude.

The effect obtained by this treatment would be compared with the results obtained by the usual methods of treatment.

The results might be due to a combined effect of the drugs and the radical operation, but might also be due to the anti-tuberculosis drugs alone, or the operation, or even to a spontaneous, natural course of the disease. In order to examine the effect of the anti-tuberculosis drugs alone, it was planned to treat a second group of patients with the drugs but without operation. This group is referred to as group B in the subsequent text. The treatment in this group should otherwise be as identical as possible to the treatment in group A; since it was originally considered that the investigation would have to be discontinued in July 1960, the treatment given to the patients in group B had, however, to be limited to only one year. For ethical and human reasons, control groups (i) undergoing radical operation without addition of anti-tuberculosis drugs and (ii) receiving no treatment could not be included in the plan.

In order to examine the effect of factors other than the operation on prognosis, it had been preferable to establish criteria for certain subgroups of group A and admit patients for treatment only when they satisfied these criteria. Again, for human reasons this was not possible, and it was decided to leave to chance the types of patients to be represented in the material under investigation. The plan for allotting patients to group A or group B is discussed on pages 27-28.

Practical Considerations

Before the studies could be started, certain practical questions had to be considered. Thus, it was necessary to consider whether the number of persons in the population suffering from tuberculosis of the spine was sufficiently large for the required number of patients to enter the hospital within the period available for the investigation. It was also necessary to consider whether the hospital was sufficiently well equipped and its regulations such as to permit the carrying out of the necessary examinations and treatment of the required number of patients—again within the period available. Finally, it had to be considered whether it would be possible to regulate and control the treatment so that it could be carried out according to plan.

(a) *Number of patients in the population*

No exact data are available in regard to the number of individuals in South Korea suffering from tuberculosis of the spine. However, mass tuberculin testing carried out in 1957-58, and mass radiography of tuberculin-positive individuals in Seoul and the surrounding districts, from which most of the patients would come, illustrate the nature and extent of tuberculosis infection in general (KOREAN MINISTRY OF HEALTH AND SOCIAL AFFAIRS 1957, 1958, HAN 1959).

<i>Age (years)</i>	<i>Proportion giving positive result in the tuberculin test (per cent)</i>
5	26.7-47.5
10	63.9-67.7
15	91.3

Pulmonary tuberculosis was found in 4.2-5.8 per cent.

As this population amounted to more than five million people, it can be calculated that there were probably about 250,000 persons

suffering from pulmonary tuberculosis in the area which the hospital would mainly serve. This prevalence was so high that it was believed that the number of persons suffering from tuberculosis of the spine was large enough to ensure the availability of study material required for the plan of investigation, and that sufficient patients would consult the hospital within the period available.

(b) '*National Medical Center in Korea*'

This is a general hospital, constructed in 1957-58, and operated jointly by the Scandinavian and South Korean Governments for the main purpose of providing postgraduate training for Korean doctors and nurses. Its equipment is that of a Scandinavian university hospital. At the time of this investigation it had departments for 18 specialities, including the following of particular interest for the investigation: orthopaedic surgery, radiology, biochemistry, microbiology, pathology, anaesthesiology and physiotherapy. Every clinical department had an out-patient clinic and a ward section. Each department had a Scandinavian specialist as head of department, possibly with a Scandinavian assistant, and several Korean doctors.

Patients wishing to be admitted to the hospital had to file an application containing particulars of sex, age, nature of complaint, etc. The first medical examinations were undertaken at the out-patient clinic, after which the Scandinavian head of the department decided as to admission to the ward. After discharge from the hospital, the patients were instructed to return to the out-patient clinic for control examinations.

According to the hospital regulations, at least 75.0 per cent of the patients were treated free of charge. They belonged to the poorest sections of the population. In practice, more than 90.0 per cent of the patients with tuberculosis of the spine belonged to this category. Cases of particular interest from the medical point of view could also be treated free of charge. The flexibility of the regulations made it possible to examine and treat patients without regard to cost. Medicaments for use in ambulatory treatment were also given free of charge.

From these considerations it will be noted that the hospital had the necessary equipment, and its regulations were such as to enable the necessary examinations to be carried out and the proposed treatment to be given. On the other hand, the number of patients that could be admitted was limited by the fact that the orthopaedic ward had only 30 beds and was expected to receive orthopaedic patients of all kinds.

(c) *Regulation and control of treatment*

Since the plan was to give patients a great deal of freedom, control was required only of the post-operative hospitalization period and to ensure that anti-tuberculosis drugs were taken according to instructions. Control of the post-operative hospitalization period could be effected by planning the discharge, e.g. a week in advance and making the necessary arrangements. To ensure that the drugs were actually taken, a nurse could watch their actual ingestion as long as the patients were in the hospital, but this could not be supervised in ambulatory patients; it is obvious that the patients might sometimes sell the free drugs to obtain money. It is also normal for patients to tire of taking drugs over long periods, or for a patient who feels completely fit to forget his prescribed drug regimen. In the conditions of life in South Korea it was thought most effective to give patients a supply of drugs for only two to three months at a time and to instruct them to return for new supplies and for a control examination, which included a test for PAS in the urine.

Procedures

(a) *Construction of patient groups*

Inclusion of patients in the studies. Group A was intended to include unselected patients. For different reasons, some selection was nevertheless inevitable. However, on the whole it was of such a nature that it is believed not to have had any important effect on the results. The main selection factors are discussed below.

As mentioned on page 25, patients filed an application for examination at the out-patient clinic. As a rule all applicants were given an appointment, but there were two exceptions: (i) individuals living more than six to eight hours' travelling distance from the hospital were not admitted, since it was thought that they would probably have difficulty in attending regularly for subsequent control examinations; (ii) when too many individuals applied, patients with paraplegia were favoured but the procedure was mostly that, from the pile of applications, as many patients as could be admitted to the hospital were drawn by a 'blind' procedure.

Division of patients into groups. At the out-patient clinic, a preliminary interpretation of the radiographs of the spine was made. Patients were divided into those with one to three vertebrae affected, every second one of these was consistently included in groups A and B alternately. All those with four or more vertebrae affected were included in group A. Thus, with the exception of the latter, patients were assigned to the two groups in the order in which they finished their first examination at the out-patient clinic, without any selection. At certain times it was impossible to admit all patients to the ward, because of the limited capacity of the orthopaedic ward, because it was required to treat orthopaedic cases of all kinds, and owing to the fact that the main purpose of the hospital was teaching. During such periods, which lasted for as long as two weeks at a time, patients were

advised to go elsewhere for treatment, i.e. no selection of cases was then made and no patient was included in either group.

About two months were required from the time the first patient was admitted to the beginning of the investigation. All patients with tuberculosis of the spine admitted during this period were subsequently included in group A, while the establishment of group B only started after these first two months. Since it was proposed to treat these patients for a period of one year, and since the investigation was to be completed by July 1960, the inclusion of patients in this group was terminated in June-July 1959. Because of the limited time thus available for the establishment of group B, it ultimately included only 45 patients, as contrasted to 100 patients in group A. As already mentioned, group B was intended to be constructed only of patients with one to three vertebrae affected; but if subsequent, more exact study showed a more extensive lesion than that assessed during the preliminary interpretation of the radiographs, the patients were nevertheless retained in the group. Group B also contained a few patients who had originally been allotted to group A but who, after a period of ambulatory treatment, had decided that they did not wish to undergo operation. Finally, it contained two children who had been admitted to the paediatric department for other reasons, and who had been treated and examined by that department for several months before they were ultimately transferred to the orthopaedic department.

After the construction of groups A and B had been completed, a further group of eight patients were operated upon, without the addition of anti-tuberculosis drugs.

(b) *Examinations and diagnosis*

The examinations included clinical, radiological, biochemical, microbiological and histological examinations.

Clinical examinations. At the patient's first visit to the out-patient clinic, the clinical examination was carried out by a Korean doctor on the staff of the department. He then demonstrated the patient to the author (in 85.0–90.0 per cent of the cases) or to his Scandinavian assistant. Following admission, all patients were examined personally by the author. The control examinations were carried out by a Korean doctor, sometimes alone and sometimes with the author or his Scandinavian assistant. In a follow-up study in the spring of 1960, the clinical examination of all the patients seen was carried out by the author; in a similar study in the autumn of 1961, the author examined 136 out of the 139 patients seen, the remainder being examined by other

doctors from the hospital. In all these examinations one of the Korean orthopaedic surgeons, or the author's Korean secretary, who spoke English fluently, was available as interpreter.

Radiological examinations were carried out in the Department of Radiology of the hospital.¹ A radiological examination formed part of the initial and final examinations of all patients, and of most of the control examinations. Plain films were taken of the antero-posterior and lateral views, and for most patients tomograms were taken once or several times with a distance of $\frac{1}{2}$ –1 cm, in frontal and sagittal planes. The radiographs were examined at the time by the Department of Radiology. When the present report was prepared, however, all radiographs of the spine were reviewed by the author in discussions with a leading radiologist.²

Radiographs of the lungs were made of all patients at the initial examination, at occasional control examinations, and during the final follow-up examination. The radiographs of patients with pathological findings were reviewed and the development which had occurred was assessed by a leading specialist in chest diseases.³

Biochemical examinations were carried out at the Department of Biochemistry of the hospital.⁴ The patients' urine was tested on all visits to the out-patient clinic, on admission to the ward, and possibly also during hospitalization, to determine pH, specific gravity and content of protein, pus and sugar. In addition, the erythrocyte sedimentation rate (ESR) was measured, haemoglobin (Hgb) was determined and the Mantoux tuberculin test was carried out; the blood group was determined after admission. The determination of PAS in the urine by the ferric chloride method was undertaken by the staff of the Department of Orthopaedic Surgery.

Microbiological examinations were carried out at the Department of Microbiology of the hospital.⁵ Examinations for tubercle bacilli were made in material removed at operation, in pus obtained by aspiration or from draining sinuses, in the urine and sometimes in the sputum. Examinations for drug resistance of tubercle bacilli could be

¹ Dr. B. Lilja, M.D., Halmstad, Sweden, Dr. N. Lauge-Hansen, M.D., Randers, Denmark, and Dr. K. Liverud, Oslo, Norway, were successively in charge of this department during the investigation period.

² Professor E. Poppe, M.D., Oslo, Norway.

³ Dr. A. Tuxen, M.D., Oslo, Norway, while he was in charge of the Department of Chest Diseases at the hospital in Seoul, 1962.

⁴ Professor S. L. Sveinsson, M.D., Oslo, Norway, and Dr. B. Rosenlund Oslo, Norway, were successively in charge of this department during the investigation period.

⁵ Dr. K. Kalbak, M.D., Copenhagen, Denmark, was in charge of this department during the whole of the investigation period.

carried out only from the spring of 1960 onwards. Typing of tubercle bacilli could not be done at the hospital. In certain cases the examination for bacilli in the urine was undertaken only after the patient had begun to receive anti-tuberculosis drugs.

Histological examinations were carried out at the Department of Pathology of the hospital.¹ When the investigation was completed, all the sections made were reviewed by a leading histopathologist.² (The expression 'tuberculous granulation tissue' has been used in this report for the sake of brevity where the histological features found were similar to those found in tuberculosis, although this finding in itself is no definite proof of tuberculosis.)

The *diagnosis* was based on the case history and on the results of the clinical and radiological examinations. It was verified or supported by the microbiological and histological findings in 81 cases out of the total of 100 in group A, and in 13 cases out of the total of 45 in group B. During the investigation period, a pre-operative diagnosis of tuberculosis was amended as a result of the operative and the laboratory findings in one case to that of osteoid osteoma, in a second case to haemangioma, and in three cases to staphylococcal osteomyelitis; these five cases were not included in the investigation.

(c) *Treatment*

Medication included anti-tuberculosis drugs in the following doses:

<i>Drug</i>	<i>Dose</i>
INH	5-6 mg per kg body-weight per day in adults, somewhat more for children
PAS	0.2-0.3 g per kg body-weight per day
SM	1 g per day in adults; in small children, $\frac{1}{2}$ - $\frac{3}{4}$ g per day, or 1 g every other day

In accordance with the plan of the investigation, the length of the pre-operative medication period was left to chance. The post-operative period varied, as will be discussed later. Patients were given multi-vitamin tablets as a matter of routine; a few were also given iron tablets.

Operation. Patients were admitted for surgery as soon as this was permitted by the limited ward capacity. The operation was performed immediately on completion of all necessary examinations, unless some

¹ Professor K. Arnesen, M.D., Oslo, Norway, and Dr. J. Ringsted, M.D., Copenhagen, Denmark, were successively in charge of this department during the investigation period.

² Professor K. Arnesen, M.D., Oslo, Norway.

intercurrent disease made postponement essential. The only exceptions to this rule were the first five patients, who were kept in hospital for some weeks before operation. Pulmonary tuberculosis was not regarded as a contra-indication for operation, nor was anaemia.

The operative approaches were uniformly as follows:

<i>Vertebrae affected</i>	<i>Approach</i>
Cervical and dorsal 1-3	Cervical incision along the medial border of the sterno-cleido-mastoideus muscle
Dorsal 4-12	Costotransversectomy or simple rib resection of one to three ribs; the latter was often sufficient in children
Lumbar 1-4	Transversectomy or kidney incision
Lumbar 5-Sacrum	Transperitoneal approach

The bony lesion was exposed through the abscess, where this was present. It was necessary in some cases to chisel a window through grossly normal bone in order to reach a lesion in the interior of a vertebra, diagnosed by radiography. A thorough curettage was carried out with removal of affected bone and disc tissue as completely as possible. While this was being done, an abscess on the other side of the spine would, as a rule, be entered. The dura was often exposed, and always in cases with paraplegia. With this technique, and with extensive lesions, inspection of the whole of the lesion was not possible; the 'inspection' had partly to be carried out by palpation with the index finger, or even by means of the curette.

The abscess wall and the sinus tract, where this was present, were curetted, but were removed only to the extent that such removal could be easily effected.

Suction was used throughout the operation in an attempt to reduce the spread of pus and diseased material in the wound. At the end of the operation, the wound was flushed vigorously with large amounts of saline solution, large tubes being used to reach the bottom of deep pockets. The operation was completed with a final flush with hydrogen peroxide, 2 g or more of powdered SM were deposited in the cavity, and the wound was closed by primary suture. In operations in which the approach was by kidney incision, a drain was left in for two to three days. Bone grafts and post-operative local instillation of anti-tuberculosis drugs were never used.

Operations on double lesions were carried out in two stages. Cases with a large abscess on both sides were operated on bilaterally in one or two stages. The second operation, as well as operations for complicating tuberculosis of the hip, knee, sacro-iliac joint or pubic bone, were carried out fourteen to twenty-five days after the first operation.

Radiological examination of the site was usually carried out during the operation (Fig. 2). A post-operative radiological examination was carried out after costotransversectomy or rib resection to determine whether pneumothorax was present.

The operation was performed under general anaesthesia, with intubation and with blood transfusion.



Figure 2. *Radiological control of the site during operation*

Mobilization and hospitalization. Patients were allowed to get up as early and as much as they wanted, even on the first days after the operation, and no form of support was provided. Training in active back exercises was given by the hospital physiotherapists during in-patient treatment, except for the first one or two days after the operation. Out-patients were advised to do exercises at home and were given an illustrated instruction sheet.

Hospitalization was reduced to the time necessary for the completion of pre-operative examinations, for the wound to heal and for additional operations to be carried out. Patients were discharged even if still bedridden.

(d) *Analysis of findings*

All periods of time were recorded, from the day of operation for group A, and for group B from the day on which drug treatment was commenced by the hospital. Where the operation in group A

was performed in two stages, or where re-operation was necessary, the time was recorded from the day of the first-stage operation or first operation respectively.

The findings were calculated on the basis of the total number of patients in each group. In a few instances they were based on the number of examinations carried out, and this will be pointed out where appropriate in the text.

The standard error (S.E.) of the difference between two proportions was computed from the formula (HILL, 1961):

$$\text{S.E. } (p_1 - p_2) = \pm \sqrt{Pq \left(\frac{1}{N_1} + \frac{1}{N_2} \right)}$$

where N_1, N_2 = number of patients in the two groups

p_1, p_2 = proportion of patients in the two groups having the characteristic under discussion

P = $p_1 + p_2$

q = $100 - P$

The significance of any difference between the proportions was assessed as follows:

<i>Value of $(p_1 - p_2) \div \text{S.E.}$</i>	<i>Statistical significance</i>
> 3	Significant
$2 - 3$	Probable
< 2	Insignificant

Definitions

Certain terms frequently used in the text are defined as follows, and are listed alphabetically:

Adults: individuals 15 years of age or above.

Children: individuals 1-14 years of age.

Clinical kyphosis groups: there are five of these groups (Fig. 3), the criteria for which are as follows:

<i>Group</i>	<i>Criteria</i>
0	No visible change in the back
1	Protrusion of spinous processes but no angulation
2	Slight but definite angulation
3	Marked angulation
4	Hunchback

Completely bedridden: the patient was lying down the whole day, except perhaps for a period of two hours at the most (see also *Completely up and about*, *Partly bedridden*).

Completely up and about: the patient was up and about the whole day, except perhaps for a period of two hours at the most (see also *Completely bedridden*, *Partly bedridden*).

Complete working capacity: the patient was able to choose his type of work without having to take the condition of his back into consideration, and was able to achieve a performance equal to that of other individuals engaged in similar type of work. Housewives were said to have complete working capacity when they could carry out their housework without assistance. For children, the criterion was the ability to attend school, play and run about like healthy children of the same age (see also *Partial working capacity*).

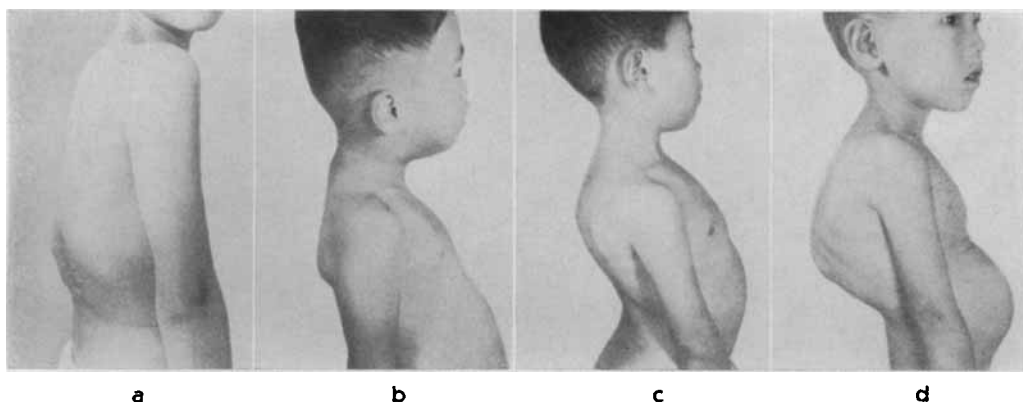


Figure 3. *Clinical kyphosis*

- a. *Kyphosis 1* — protrusion of spinous processes but no angulation of the spine.
- b. *Kyphosis 2* — slight but definite angulation of the spine.
- c. *Kyphosis 3* — marked angulation of the spine.
- d. *Kyphosis 4* — hunchback.

Early paraplegia: paraplegia which began within two years of the appearance of the spinal symptoms (see also *Late paraplegia*).

Fusion: bony union between the vertebral bodies appeared present in radiographs in both the antero-posterior and the lateral views; no distinction was made between complete and partial fusion.

Large vertebral defect: a defect measuring more than one-half of the transverse, sagittal or longitudinal axis of the vertebral body, as seen on radiographs, but without the body being sub-totally or completely destroyed (see also *Small vertebral defect*).

Late paraplegia: paraplegia which began more than two years after the appearance of the spinal symptoms (see also *Early paraplegia*).

Lower spinal lesion: a lesion in which the lumbar region of the spine and the sacrum are involved (see also *Upper spinal lesion*).

Partial working capacity: ability to work to a lesser extent than others engaged in the same type of work, e.g. part-time work, 'light' farm work or housework, etc. (see also *Complete working capacity*).

Partly bedridden (Partly up and about): anything between the extremes of completely bedridden and completely up and about.

Previous medication: medication with INH, PAS or SM, received before the first attendance at the out-patient clinic, but which ceased more than one month before medication was provided by the hospital; if medication ceased less than one month before it was provided by the hospital, it was regarded as pre-operative medication.

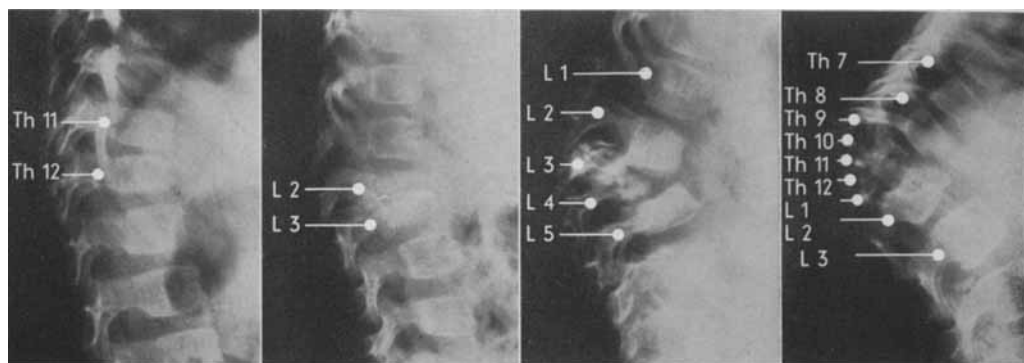


Figure 4. Radiological groups

- a. Group 1 — changes of structure or small defects in 1–2 vertebrae.
- b. Group 2 — changes of structure or small defects in 3–4 vertebrae, large defects in 1–2.
- c. Group 3 — changes of structure or small defects in 5–6 vertebrae, large defects in 3–4, sub-total or total destruction of 1–3 vertebrae.
- d. Group 4 — changes of structure or small defects in 7 or more vertebrae, large defects in 5 or more, sub-total or total destruction of 4 or more vertebrae.

Radiological deterioration: an increase in the pathological changes, as assessed from the radiographs.

Radiological groups: there are four of these groups (Fig. 4), for which the criteria are as follows (it should be noted that the classification is not affected by the presence or otherwise of abscesses or kyphosis):

Group	Criteria
1	Changes of structure or small defects in 1–2 vertebrae
2	Changes of structure or small defects in 3–4 vertebrae, large defects in 1–2
3	Changes of structure or small defects in 5–6 vertebrae, large defects in 3–4, sub-total or total destruction of 1–3
4	Changes of structure or small defects in 7 or more vertebrae, large defects in 5 or more, sub-total or total destruction of 4 or more

Radiological improvement: (i) a more normal appearance of the vertebral structure; (ii) sharper contours; (iii) a decrease in the defects present, or at least no increase in such defects (Fig. 5); (iv) fusion.

Radiological kyphosis: the angle between the axis of the spine above the lesion and the extension of the axis below the point at which the deformity was greatest (Fig. 6).

Radiological no change: no change in radiological findings, or signs of both improvement and deterioration, but to an equal extent. Changes

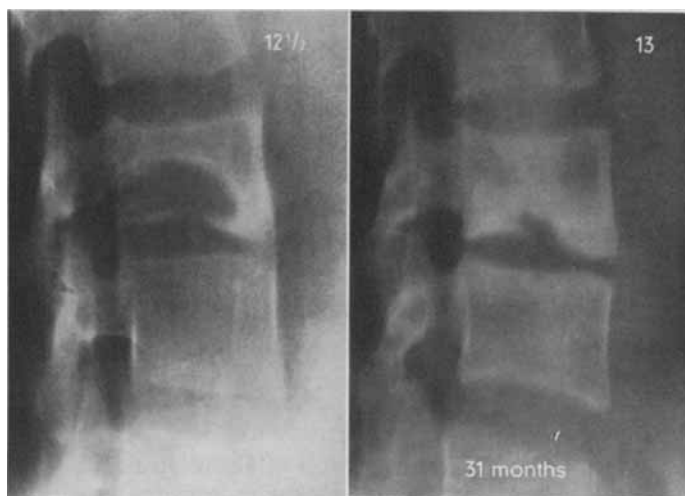


Figure 5. *Decrease in defects after operation*
Case 14 — Female 22 years, before operation and after 31 months.

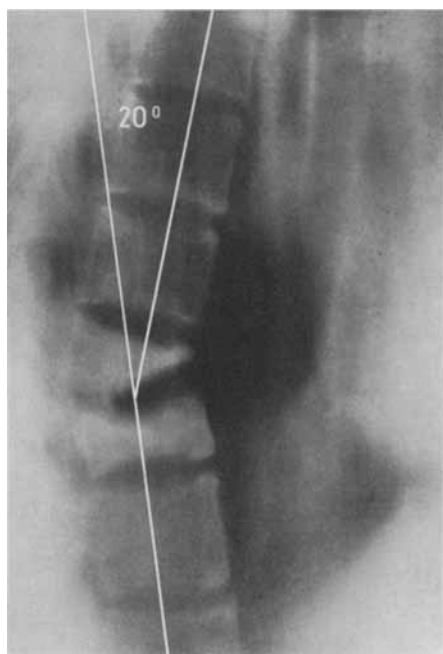


Figure 6. *Measurement of radiological kyphosis*

The kyphosis was measured as the angle between the axis of the spine above the lesion and the extension of the axis below it.

in kyphosis and in abscess shadow were not taken into account in assessment of the radiological development.

Recovery from paraplegia: when any bladder or bowel symptoms had disappeared, there was motor and sensible recovery and disappearance

of increased muscular tonus and of clonus, where present, while a slight increase of tendon reflexes and an inversion of plantar reflexes might persist.

Slight complaints: a 'feeling' in the back which patients distinguished from ordinary pain, and which might perhaps be a sensation of discomfort, weakness, tiredness or stiffness. It could occur without any apparent cause, or following a whole day of heavy farm or housework. Patients would sometimes only notice the 'feeling' and pay no more attention to it; at other times they would change position, or even stop working for a moment or a few minutes. The term could also cover tenderness to direct or indirect pressure on the lesion.

Small vertebral defect: a defect which measured less than one-half of the transverse, sagittal or longitudinal axis of the vertebral body, as seen on radiographs (see also *Large vertebral defect*).

Upper spinal lesion: a lesion in which the cervical and dorsal regions of the spine are involved. The term also covers lesions in which both the dorsal and lumbar regions are involved. The inclusion of those which involve only the 12th dorsal and several lumbar vertebrae may perhaps be questioned. This point, however, is of purely academic interest in the present investigation, since such lesions were found in only two patients, in whom Th12-L2 and Th12-L5 were affected (see also *Lower spinal lesion*).

The Investigation

1. Treatment with Anti-Tuberculosis Drugs in Conjunction with Radical Operation, Group A.
2. Ambulatory Treatment with Anti-Tuberculosis Drugs, Group B.
3. Other Groups of Patients.

Treatment with Anti-Tuberculosis Drugs in Conjunction with Radical Operation, Group A

1. SURVEY OF PATIENTS

The *age distribution* is given in Table 3. Of the total of 100 patients, 42 were children (42.0 per cent) and 58 were adults (58.0 per cent). Their ages ranged from 17 months to 58 years. The age distribution of the Korean population is also given in Table 3 and there is, on the whole, good agreement between the age distribution of the patients and that of the population. However, in the age range 25-44 there is a higher proportion among the patients, and in the age range from 45 onwards the proportion of patients is lower. The group of patients included 43 males and 57 females.

TABLE 3. *Age distribution of 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation for tuberculosis of the spine (Group A), and age distribution in the Korean population, 1956, according to Korean Ministry of Public Health and Social Affairs (1957)*

Age Years	Patients		Korean population Per cent
	Number	Per cent	
0-4	20	20.0	15.6
5-14	22	22.0	24.5
15-24	19	19.0	20.1
25-44	35	35.0	23.6
45-59	4	4.0	10.9
60 and above	—	—	5.3
Total	100	100.0	100.0

Information on *duration of symptoms* is given in Table 18 (see page 64), where it is discussed in connexion with the results of treatment. The range was from two months to seventeen to eighteen years.

The data on the *region of the spine involved*, assessed by radiographs, were as follows:

<i>Region of spine</i>	<i>Number of lesions</i>	
	<i>Children</i>	<i>Adults</i>
Cervical	—	—
Cervico-dorsal	4	3
Dorsal	14	14
Dorso-lumbar	7	11
Lumbar	9	26
Lumbo-sacral	8	6
Sacral	—	1
Total:	42	61

It will be seen that there were 103 lesions among the 100 patients, since three adults had double lesions (i.e. two lesions separated by at least one apparently normal vertebra). The data are summarized in Table 4.

Vertebrae affected. The frequency with which different vertebrae were involved is shown in Fig. 7, and the number of vertebrae affected is given in Table 5. The 42 children had a total of 181 vertebrae affected, and the 58 adults 235 vertebrae, giving an average of 4.3 for the children and 4.0 for the adults. Twenty-eight patients (28.0 per cent) had one or two vertebrae affected.

The distribution of *radiological groups* is shown in Table 6; children had lesions in groups 3 or 4 more often (33 out of 42 cases) than adults (29 out of 58 cases). No correlation was found between the duration of symptoms and radiological grouping. The use of the classification systems suggested by HELLSTADIUS (1937) and ALVIK (1949) (see page 20), was made difficult by the extensive destruction in most cases; probably 84 lesions should be classified as extensive or central and 10 as vesicular according to HELLSTADIUS, and 96 as central according to ALVIK. According to the classification suggested by FELLÄNDER (1954), 68 cases had a large abscess shadow on radiographs, 25 had a small shadow, while nothing definite could be said about abscess shadows in seven cases.

Pulmonary and extrapulmonary complications. Sixty-eight patients (68.0 per cent) were found to be suffering from 86 complications, 11 of the patients suffering from both pulmonary tuberculosis and extrapulmonary complications. A total of 16 patients had more than one complication at the same time. Pulmonary tuberculosis as determined by radiological examination was found in 31 patients (31.0 per cent; 11 children and 20 adults); among these patients were cases with disseminated tuberculosis and with extensive infiltrations and cavities.

TABLE 4. *Region of spine involved in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Region of spine involved	Children		Adults		Total		
	Patients	Lesions	Patients	Lesions	Patients		Lesions
	Number	Number	Number	Number	Number	Per cent	Number
Upper spine	25	25	25	26	50	50.0	51 ¹
Upper and lower spine	—	—	2	4	2	2.0	4 ¹
Lower spine	17	17	31	31	48	48.0	48 ¹
Total	42	42	58	61	100	100.0	103 ¹

¹ The upper spine was involved in 53 lesions, and the lower spine in 50 lesions.

TABLE 5. *Vertebrae affected in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Number of vertebrae affected	Children	Adults	Total	
	Number	Number	Number	Per cent
1	—	1	1	1.0
2	6	21	27	27.0
3	10	11	21	21.0
4	9	8	17	17.0
5-9	17	14	31	31.0
10 or more	—	3	3	3.0
Total	42	58	100	100.0

TABLE 6. *Radiological grouping of 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Radiological group	Children	Adults	Total	
	Number	Number	Number	Per cent
1	1	1	2	2.0
2	8	28	36	36.0
3	21	21	42	42.0
4	12	8	20	20.0
Total	42	58	100	100.0

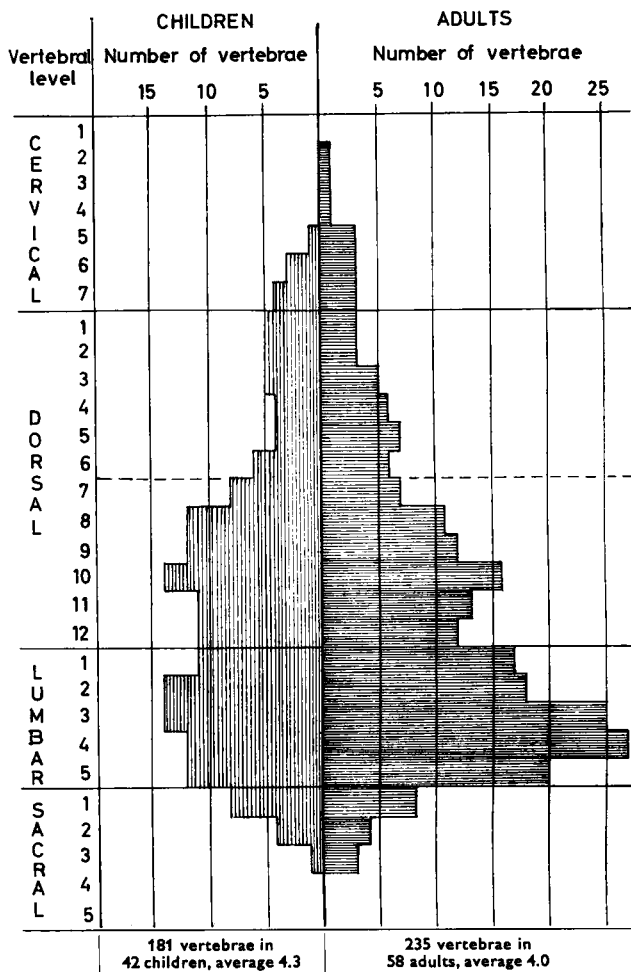


Figure 7. Vertebrae affected in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation

Extrapulmonary complications were found in 48 patients (48.0 per cent; 14 children and 34 adults):

Complications	Number of complications	
	Children	Adults
Pulmonary tuberculosis	11	20
Paraplegia	8	13
Sinus formation	5	16
Extraspinal tuberculosis of bones and joints	2	6
Tuberculosis of urogenital organs and lymph glands	—	5

In addition, several patients suffered attacks of malaria during their stay in hospital. A high percentage were probably infested with parasites (see page 99).

The *Mantoux tuberculin test* was positive in all cases except the following:

Case 52, a 38-year-old Female. General condition poor. Group 2 lesion in Th10-11. Acid-fast bacilli demonstrated in pus from operation and tuberculous granulation tissue found on histological examination. Bilateral pulmonary tuberculosis, far advanced, with cavities. Mantoux test negative on several examinations.

Other tests. The urine was cultured for tubercle bacilli at least once and sometimes on several occasions for each case: acid-fast bacilli were found in four cases, and not found in 96 cases.

A cardiolipin-lecithin flocculation test for syphilis (VDRL) was carried out on all patients except children below 5-6 years of age. None was found to be seroreactive.

The *blood group* was determined in all cases and the distribution was close to that found in the first 2,000 such determinations carried out at the hospital (HEGER 1960) as shown below:

<i>Blood group</i>	<i>Percentage found</i>	
	<i>Patients in group A</i>	<i>Results of HEGER (1960)</i>
0	27.0	26.9
A	28.0	33.7
B	30.0	28.0
AB	15.0	11.4
Rhesus +	100.0	99.5
Rhesus -	0.0	0.5

The data on the *period of observation* are as follows:

<i>Observation (months)</i>	<i>Number of patients</i>	<i>Cumulative total</i>
28-34	56	56
22-27	38	94
6-9	2	96
Dead	4	100

The two cases with an observation period of six to nine months could not be traced at the last follow-up examination. In two cases, in-

formation was provided by the author's successor,¹ thus allowing an observation period of twenty-eight to thirty months to be achieved; the findings were the same in both cases as those of the author after twenty to twenty-one months of observation.

2. TREATMENT

Medication with anti-tuberculosis drugs. Previous medication had been received by 22 patients.

The doses given by the hospital were those set out elsewhere (see page 30). Data on pre-operative treatment with INH and PAS are given in Table 25 (see page 68). Medication lasted from three days to eight years, and was less than one month in 30 patients and less than two months in 54 patients. Additional SM was given for less than one week in 42 patients, for one to two weeks in 31 patients, and for more than two weeks in 27 patients.

Post-operative treatment with INH and PAS was shorter than twelve months for 18 patients. These failed to come for control examinations; when traced at the last follow-up examination, it was learned that the reason for their not coming was that they had felt completely well. In 39 patients the treatment lasted longer than the planned twelve to eighteen months, partly as a result of persistent symptoms, but partly also because the doctor at the out-patient clinic gave further drugs at the control examination, solely from habitual practice. Post-operative medication with SM usually coincided with post-operative hospitalization.

To investigate whether ambulatory patients were taking their drugs as instructed, 100 check examinations for PAS in urine were carried out in patients selected at random in the middle of the investigation period and without the patients knowing that such a test was being done. The reaction was positive in 79 cases and negative in 13; in the remaining 8 cases, the patients stated that their supplies of PAS had been used up during the previous eight to ten days, and volunteered this information before they were confronted with the results of the test.

Data on *recumbency*, estimated as the interval between the operation and when the patients were completely up and about, are given in Table 7; it was less than three months in 43 patients, 43.0 per cent, and less than six months in 71 cases, 71.0 per cent.

¹ Dr. H. Thrap-Meyer, Head of the Department of Orthopaedic Surgery, The National Medical Center in Korea, 1962.

TABLE 7. *Recumbency in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A), based on the interval between operation and the time when the patients were completely up and about*

Recumbency	Children	Adults	Total	Cumulative total	
	Number	Number	Number	Number	Per cent
Less than 1 month	10	—	10	10	10.0
1-3 months	15	18	33	43	43.0
3-6 "	12	16	28	71	71.0
6-12 "	3	15	18	89	89.0
12-24 months	1	4	5	94	94.0
Partly or completely bed-ridden at last follow-up examination.	—	3	6	100	100.0
Dead while still bedridden	1	2			
Total	42	58	100	100	100.0

Immobilization. The first five patients were provided with plaster-beds and body casts, but their use was not enforced; as a result, plaster-beds were generally found on the floor under the patient's bed, while body casts were removed by the patients on their return home. No means of immobilization were provided for the next 95 patients.

Hospitalization. Of the 100 patients, six orphans were admitted from — and discharged to — institutions with hospital facilities. In the remaining 94 cases, hospitalization lasted on the average for thirty-five days (Table 8); it was within the planned period of four to six weeks for 67 patients out of these 94 (71.2 per cent) and for five of the remaining six patients. A study of the 27 patients who were hospitalized for more than forty days shows that 12 of them had pulmonary tuberculosis or extraspinal bone and joint tuberculosis, and 10 had paraplegia.

TABLE 8. *Duration of hospitalization of 94 out of 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)¹*

Hospitalization Days	Children	Adults	Total	Cumulative total	
	Number	Number	Number	Number	Per cent
13-21	16	12	28	28	29.8
22-30	8	18	26	54	57.5
31-40	2	11	13	67	71.2
41-60	6	10	16	83	88.3
61 and above	4	7	11	94	100.0
Total	36	58	94	94	100.0

¹ Six patients who were admitted from and discharged to institutions with hospital facilities are not included.

Operations

<i>Type of operation</i>	<i>Number of patients</i>	<i>Remarks</i>
One-stage	97	—
Two-stage	} 2 1	Double lesion in spine Extensive lesion
Re-operation once	10	{ Residual abscess and possible sinus formation Tuberculosis of the hip (2 cases), knee, sacroiliac joint and pubic bone (1 case each)
Re-operations three times	1	
Additional operations	5	

All re-operations were carried out within three to fourteen months of the original operation, except the third re-operation in one case which was re-operated three times.

3. OPERATIVE FINDINGS

Gross pathology was found in 99 out of the 100 cases. The macroscopic findings were as follows:

<i>Findings</i>	<i>Number of cases</i>
Pus and/or caseous material	85
Granulation tissue and/or bone sand	96
Bone and/or disc sequestrum	92

The dividing line between bone sand and bone sequestrum was taken as 3–4 mm in any dimension (Fig. 8).

No abscess was found on operation in five cases out of 68 with a large abscess shadow on the radiograph and in eight cases out of 25 with a small shadow.

The *microbiological and histological findings* are shown in Table 9; acid-fast bacilli were found in 53 cases and not found in 40 cases.

Tuberculous granulation tissue was found in 73 cases and probable tuberculosis in one, a total of 74 cases. Necrosis was found in 64 cases, corresponding to 64.0 per cent of the total and 86.5 per cent of the 74 cases with tuberculous granulation tissue.

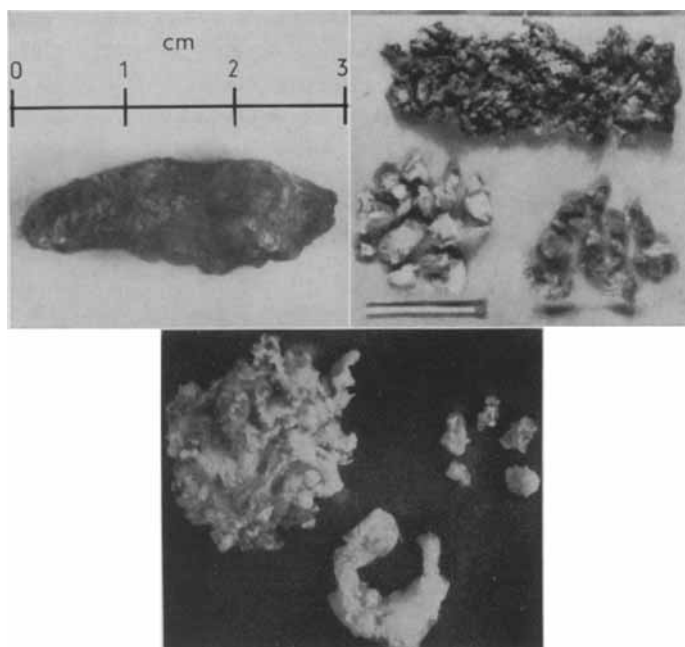


Figure 8. *Bone and disc sequestra*

TABLE 9. *Microbiological and histological findings in material removed by operation in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Histological findings	Microbiological findings			Total
	Acid-fast bacilli		No examina- tion	
	Present	Not present		Number
	Number	Number	Number	
Tuberculous granulation tissue	46	24	4	74
Chronic inflammation without definite evidence of tuberculosis	6	13	2	21
Bone tissue, cartilage, fibrous tissue	—	2	1	3
No histological examination	1	1	—	2
Total	53 ¹	40 ²	7	100

¹ 35 by culture, 18 by direct examination.

² 37 by culture, 3 by direct examination.

The pre-operative diagnosis of tuberculosis was verified or supported by laboratory findings as follows:

<i>Findings</i>	<i>Number of cases</i>	<i>Cumulative total</i>
Acid-fast bacilli and tuberculous granulation tissue	46	46
Acid-fast bacilli only	7	53
Tuberculous granulation tissue only	28	81

In spite of the finding of acid-fast bacilli, the histological examination in six cases showed 'only' chronic inflammation.

Acid-fast bacilli were found more than twice as often in cases where histological examination showed necrosis (43 cases out of 64) as in the cases without necrosis (9 out of 34).

The one patient with no gross pathological changes at operation showed bone tissue, cartilage and fibrous tissue by histological examination; unfortunately, no examination for tubercle bacilli was made. He had suffered from the disease for six years, five of them with paraplegia; treatment during these five years had been with INH, while SM was given during an eighteen-month period from May 1957 to November 1958. The operation was performed in April 1959. He was operated on for a 'tumour' on the upper arm in April 1960; histological examination showed tuberculous granulation tissue with necrosis.

4. RESULTS OF TREATMENT

(a) *Clinical findings*

The data on *back pain* were as follows:

<i>Time</i>	<i>Patients with back pain</i>	<i>Patients without back pain</i>
Before operation	90	10
After operation (at last follow-up examination, or when last seen)	6	94

In 46 cases the patients stated that the pain more or less disappeared from the day of the operation.

Ability to be up and about. The condition of the patients before operation was as follows:

<i>Condition</i>	<i>Number of patients</i>
Completely bedridden (includes one case where this was due to tuberculosis of the hip)	76
Partly bedridden	13
Completely up and about	11

By the end of the period of observation, 94 patients (94.0 per cent) were completely up and about or had been so at the last control examination, as shown in Table 7; three patients were completely or partly bedridden, and the remaining three had died while still completely bedridden.

Working capacity. Of the 27 adult men, 16 were farmers or heavy labourers, while 27 of the 31 adult females did housework; the remainder were sales personnel, office workers, students, etc. Their condition before operation was as follows:

<i>Condition</i>	<i>Number of patients</i>
Complete incapacity to work	94
Partial working capacity	4
Complete working capacity	2

The incapacity had lasted from two to three months to more than fifteen years.

The working capacity among the patients at the last follow-up examination is shown in Table 10, from which it will be seen that 80 patients (80.0 per cent) had complete working capacity; of this group, 50 were free from clinical symptoms or signs, except for kyphosis in some cases, while 30 had slight complaints. A further six patients (6.0 per cent) had partial working capacity, the failure to achieve complete capacity being due to pain, slight complaints and fear of damaging the spine in five cases; in the sixth case, bilateral pulmonary tuberculosis and polyarthritis were the probable causes, but a contribution by the spinal disease cannot be excluded.

Six patients (6.0 per cent) were incapacitated as a result of the spinal disease, and two patients (2.0 per cent) as a result of other diseases.

Of the four patients (4.0 per cent) who died, one was able to work before death occurred, while the remaining three were not; these patients are discussed later (see page 61).

Two patients (2.0 per cent) were not traced at the last follow-up examination, but both had complete working capacity when last seen, six and nine months after operation respectively, and one was said at the time of the last examination to have been recently seen at work as a shoemaker.

Slight complaints were found in 34 patients (34.0 per cent; eight children, 26 adults) after operation.

General mobility was poor in 91 patients before operation; it was good in 84 after operation.

TABLE 10. *Working capacity two to two-and-a-half years after operation in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Working capacity	Children		Adults		Total	
	Num- ber	Per cent	Num- ber	Per cent	Num- ber	Per cent
<i>Complete</i>						
No clinical symptoms or signs	32 } 40	76.1 } 95.2	18 } 22	31.0 } 69.0	50 } 80	50.0 } 80.0
Slight complaints	8 }	19.1 }	2 }	38.0 }	30 }	30.0 }
<i>Partial</i>	—	—	6	10.3	6	6.0
<i>Incapacity</i>						
Due to the spinal disease: paraplegia (2), back pain and sinus (4)	—	—	6	10.3	6	6.0
Due to other disease: tuberculosis of kidney (1), gastric trouble of uncertain character (1)	—	—	2	3.4	2	2.0
<i>Dead:</i>						
Able to work before death (1), died being still unable to work (3)	1	2.4	3	5.2	4	4.0
<i>Not traced,</i>						
But with complete working capacity when last seen	1	2.4	1	1.8	2	2.0
Total	42	100.0	58	100.0	100	100.0

The available information shows that *tenderness* was originally present in 75 out of 83 patients; no tenderness was reported in 72 out of 82 patients after operation.

Paraplegia. A total of 21 patients (eight children, 13 adults) were suffering from paraplegia before operation, and the condition had been present for a period ranging from one month to nearly five years; the 21 cases could be divided into 17 early and four late, and 11 complete and 10 incomplete. Of these patients 16 (seven children and nine adults) recovered completely, but one of the adults had nevertheless only partial working capacity; this was the patient mentioned above who was suffering from bilateral pulmonary tuberculosis and polyarthrititis. An analysis of the results is given in Table 11. Recovery was complete within three months in 10 cases, and within three to six months in six (Fig. 9); no recovery was observed later than six months.

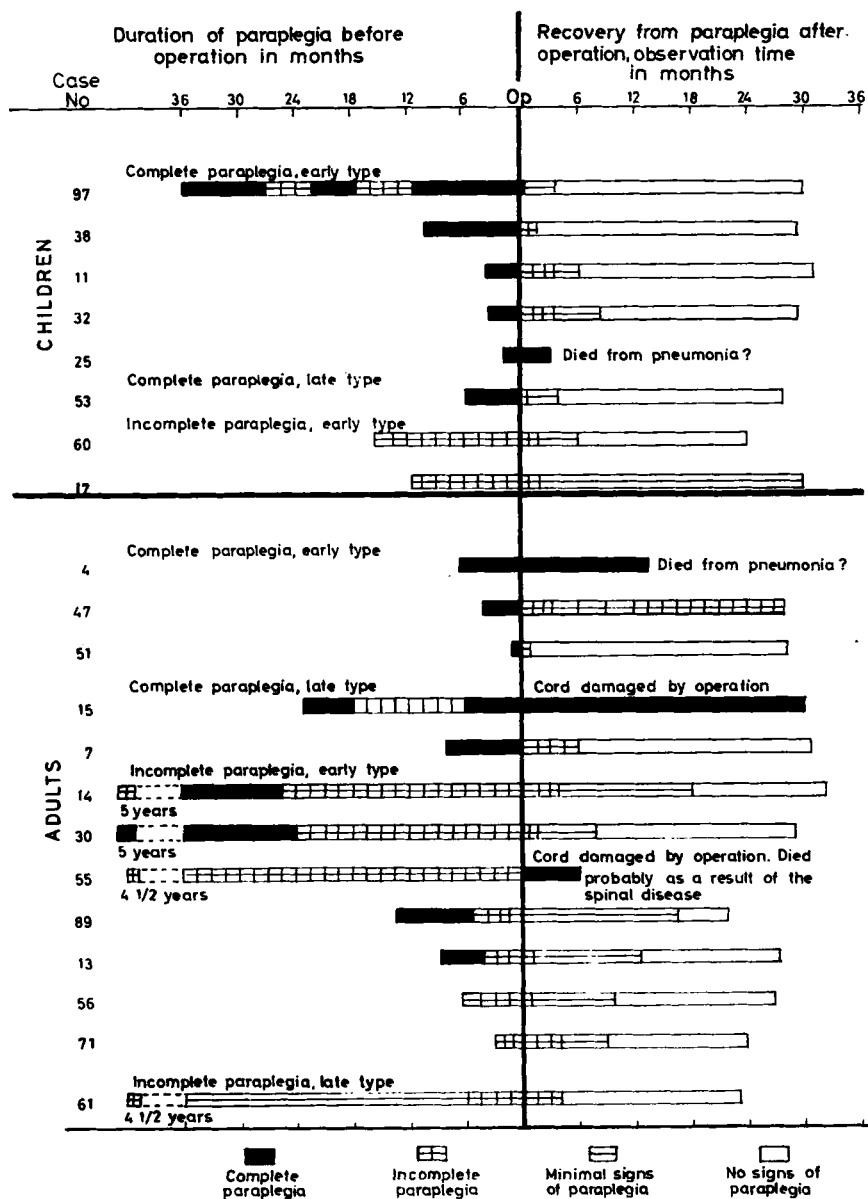


Figure 9. Recovery from paraplegia in 21 patients treated with anti-tuberculosis drugs in conjunction with radical operation

TABLE 11. *Recovery from paraplegia in 21 patients treated with anti-tuberculosis drugs in conjunction with radical operation*

Degree of recovery	Children	Adults	Total
	Number	Number	Number
Complete	7	9	16
Partial	—	1	1
None	—	1	1
Dead, as paraplegic	1	2	3
Total	8	13	21

Sinus was present in 21 patients (five children, 16 adults) before operation, and had been draining for a period in the range three months to five years. It healed within one month of operation in 13 cases; within twelve months in all of the children and in 14 of the adults. No sinus healed after that time.

The *body weight* before operation was 40–60 kg, with an average of 49.5 kg, in the 58 adult patients. The following changes in weight took place during the period of observation:

<i>Weight changes</i>	<i>Number of patients</i>
Increase	35
Decrease	8
None	6
Not measured	9

The increase or decrease was usually 3–4 kg.

Erythrocyte sedimentation rate. A value of 1–9 mm/1 hr for the ESR was found before operation in 13 patients with florid disease; the following is a typical case:

Case 61, a 37-year-old Male. Duration of disease four years. Group 4 lesion of Th10-L3. Incomplete paraplegia. On operation, large amount of pus, sequestra, etc. Acid-fast bacilli found by culture. Tuberculous granulation tissue with necrosis found on histological examination. ESR 6 mm/1 hr.

Of 20 patients with an ESR of 50 mm/1 hr or more, 19 suffered from complications in the form of pulmonary tuberculosis, tuberculosis of other organs, sinus or paraplegia.

The ESR observed is shown in Table 12; it will be seen that ESR improved markedly in the first six months after operation, after which there was little change. A high ESR was sometimes found, even though the spinal disease was probably inactive, as in the following case:

Case 29, a 20-year-old Male. Duration of disease four years. Sinus. Group 3 lesion of L1-3. Sinus healed within one month of operation. After one year, started light farm work. At follow-up examination after 28 months, no clinical symptoms or signs except kyphosis, for the last 18 months. Radiograph: fusion within 10 months of operation. ESR values:

<i>Date</i>	<i>ESR mm/1 hr</i>
May 1959 (before operation)	54
May 1960	10
November 1960	35
March 1961	14
September 1961	36

No symptoms or signs of other disease found. No pathological condition shown by radiography of the lungs.

TABLE 12. *ESR in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

ESR mm/1 hr	On admis- sion for operation	6 months after operation	12 months after operation	Last follow-up examination
	Number	Number	Number	Number
1-9	13	31	33	37
10-19	19	28	30	25
20-29	25	14	10	21
30-49	23	6	8	3
50-	20	5	2	3
Dead, ESR influenced by pregnancy or intercurrent diseases, or not examined	—	16	17	11
Total number of patients	100	100	100	100

Measurements of *haemoglobin* gave the following results:

<i>Time</i>	<i>Hgb</i> (gram per cent)	<i>Average Hgb</i> (gram per cent)
Before operation	8.4-15.7	12.1
Last follow-up examination	10.1-16.3	13.1

(b) *Radiological findings*

It will be recalled that there were 103 lesions among the 100 patients in the group (see page 42). As shown in Table 13, there was *improvement* in 81 lesions (31 children with 31 lesions and 48 adults with 50 lesions), representing 78.6 per cent of the total number of

lesions and 89.0 per cent of the 91 lesions examined at the last follow-up and where interpretation of the radiographs was possible. Interpretation was not possible in five instances, owing either to calcification of the soft tissues or to the location of the lesion to the cervico-dorsal region.

Fusion was seen on the radiographs in five lesions before operation, and became more marked in all these cases after operation. The development of fusion was as follows:

<i>Development time for fusion (months)</i>	<i>Number of lesions</i>
< 4-6	11
< 12	41
< 24-30	59

Fig. 10 illustrates development of fusion within five months.

The correlation between working capacity and the radiological findings is shown in Table 14.

Pulmonary changes. Radiographs of the lungs showed the following:

<i>Condition at operation</i>	<i>Number of patients</i>	<i>Condition after operation</i>
Pulmonary changes present	31	{Improvement 23 cases
		{No change 8 „
		{Deterioration —
Pulmonary changes absent	69	{No change 64 cases
		{Deterioration —
		{Not examined 5 cases

This means that in no case was deterioration of the lung findings seen, either among those patients where pulmonary changes were present at the time of operation, or among those not showing such changes.

(c) *Interval between operation and full resumption of work*

A total of 15 patients (13 children, two adults), i.e. 15.0 per cent, had complete working capacity within three months of the operation, as shown in Table 15. Within six months the total had risen to 45.0 per cent and within twelve months to 74.0 per cent.

(d) *Kyphosis*

The clinical kyphosis after operation is shown in Fig. 11. Data on the changes in radiological kyphosis after operation are shown in Table 16; there was an increase of 10°–50° in 27 lesions out of 103 (26.2 per cent). See also Table 44, p. 104.

TABLE 13. *Radiological findings two to two-and-a-half years after operation in 103 lesions in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Findings	Children		Adults		Total	
	Number	Per cent	Number	Per cent	Number	Per cent
Improvement	31	73.8	50 ¹	82.0	81 ¹	78.6
No change	4	9.5	5	8.2	9	8.7
Deterioration	1	2.4	—	—	1	1.0
Interpretation not possible	4	9.5	1	1.6	5	4.9
Dead	1	2.4	4 ¹	6.6	5 ¹	4.9
Patients not traced	1	2.4	1	1.6	2	1.9
Total	42	100.0	61 ¹	100.0	103 ¹	100.0
Fusion	17	40.5	42	68.8	59	57.2

¹ Three patients had double lesions; two of these showed improvement in both lesions and one patient had died.

TABLE 14. *Working capacity and radiological findings two to two-and-a-half years after operation in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Working capacity	Radiological findings					Total
	Improve- ment	No change	Deterio- ration	Interpre- tation not possible	Dead or not traced	
	Number	Number	Number	Number	Number	Number
Complete	69 ¹	5	1	5	—	80 ¹
Partial	6	—	—	—	—	6
Incapacity due to the spinal disease	2	4	—	—	—	6
Incapacity due to other disease	2	—	—	—	—	2
Patients dead or not traced	—	—	—	—	6 ¹	6 ¹
Total	79 ¹	9	1	5	6 ¹	100 ¹

¹ Three patients had double lesions; two of these had complete working capacity and showed radiological improvement in both lesions; one patient had died. They are included in this Table as individuals and not according to the number of lesions.

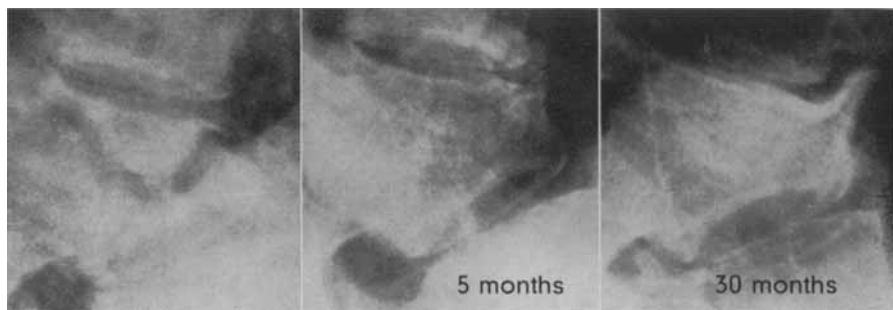


Figure 10. *Development of fusion within four to six months*
 Case 37 — Female 39 years, Th 10–11, before operation and after five and after thirty months

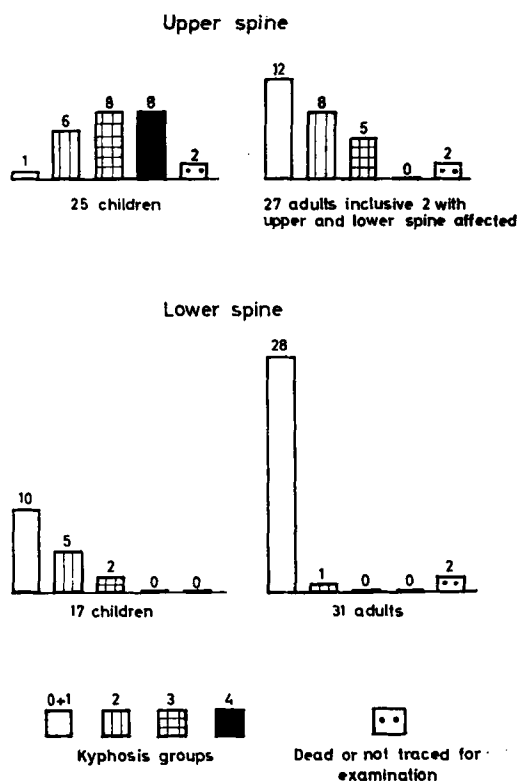


Figure 11. *Clinical kyphosis in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation, and followed up after two to two-and-a-half years*

TABLE 15. *Interval between operation and full resumption of work in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Interval	Children		Adults		Cumulative total	
	Number	Per cent	Number	Per cent	Number	Per cent
Less than 3 months	13	31.0	2	3.4	15	15.0
3-6 months	19	45.2	11	19.0	45	45.0
6-9 "	7	16.6	11	19.0	63	63.0
9-12 "	—	—	11	19.0	74	74.0
12-30 "	1	2.4	5	8.6	80	80.0
Partial working capacity, incapacity, dead, or not traced	2	4.8	18	31.0	100	100.0
Total	42	100.0	58	100.0	100	100.0

TABLE 16. *Changes in radiological kyphosis two to two-and-a-half years after operation in 103 lesions in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Changes	Lesions of the upper spine		Lesions of the lower spine		Total lesions	
	Children	Adults	Children	Adults		
	Number	Number	Number	Number	Number	Per cent
Increase 10°-50°	16	7	1	3	27	26.2
Decrease 20°	1	—	—	—	1	1.0
No change	6	19	16	27	68	66.0
Patients dead or not traced	2	2	—	3	7	6.8
Total	25	28	17	33	103	100.0

It would be reasonable to suspect a clinical kyphosis in group 4 (hunchback) to have some effect on the working capacity because of its possible influence on respiration and circulation; such an effect could not be demonstrated, since all eight children with clinical kyphosis in group 4 were found to have complete working capacity. Neither could an effect be demonstrated with regard to slight complaints, since seven had no clinical symptoms or signs other than kyphosis. Only one patient had slight complaints. A similar experience was reported by ALVIK (1949).

(e) *Complications during treatment*

The following complications occurred during treatment:

<i>Complication</i>	<i>Number of patients</i>
Damage to cord	2
Lesion of pleura	17
Lesion of inferior vena cava	1
Bloody sputum	1
Sloughing or rupture of the wound	16
Sinus formation in the wound	4
Lesion of lumbar nerve root	2
Post-operative meteorism for 10 days	1
Intolerance to PAS	2
Intolerance to SM	2

The only serious complications were two instances of damage to the cord during surgery and subsequent complete paraplegia. Both these patients were suffering from incomplete paraplegia before operation. One showed signs of meningitis after four days (headache, stiff neck, fever, Gram-negative bacilli in pure culture in the spinal fluid); but these disappeared completely in eight to ten days after chloramphenicol had been administered.

The 17 lesions of the pleura occurred in the course of the 49 costo-transversectomies or rib resections performed; none gave rise subsequently to any difficulties.

The inferior vena cava was taken for the abscess wall in one case and incised; the incision was sutured and there were no subsequent difficulties.

Bloody sputum, or rather bloody water in the mouth when the wound was flushed before closure, was seen in the following case:

Case 68. A three-year-old girl. Group 4 lesion of Th6-10. Radiography before operation showed a fusiform paravertebral abscess shadow with a tent-like projection on the left side. Since it is believed that the pleura was not injured during surgery, the case was probably an example of the penetration of the lung by the abscess, as described by HODGSON & STOCK (1960a). There was no lung reaction after operation and the post-operative course was uneventful. Discharged after fifteen days.

Sloughing or ruptures of the wound healed after a few weeks, sinuses after two to eight months.

The lesions of the lumbar nerve roots gave rise to lasting hypaesthesia and to weakness of the quadriceps. Post-operative meteorism for ten days was seen after a costotransversectomy, but not after any of the 10 transperitoneal operations.

No spread of pulmonary tuberculosis was ever seen, and meningitis only in the one case mentioned.

(f) *Re-operations, failures and relapses*

A total of 11 patients (11.0 per cent) underwent re-operation for residual abscess and possible sinus.

The following are the data on failures and relapses:

<i>Condition</i>	<i>Number of patients</i>
Complete incapacity for work during the whole observation period	4
Relapse after temporary complete capacity	2
Partial working capacity at end of period	6
Temporary relapse	1
Incapacity for work owing to other disease	2

The causes of the failure of working capacity have already been mentioned (see page 51).

(g) *Mortality*

This was nil in the immediate post-operative period, but one of the two patients with surgical damage to the cord died after five months and may possibly be regarded as an operative fatality.

A boy with paraplegia died after three months; he was said to have developed a high fever with cough, rusty expectorate and dyspnoea, and died in a few days. A woman with paraplegia died after twelve to thirteen months; the cause was said to be pneumonia, but no details were available. In neither case had the paraplegia improved before death.

A man died after twenty-three months; when last in contact with the hospital, he had been in full-time employment as a clerk from three to twelve months after operation. No information could be obtained on his working capacity during the last year of life, or on the cause of death.

5. EFFECT OF VARIOUS FACTORS ON PROGNOSIS

(a) *Operation*

The effect of operation on the results of treatment will be considered separately, when comparing group A and group B (see page 105).

(b) *Observation period*

There were some individual changes in working capacity, as found twelve months and two to two-and-a-half years after operation, but the total number of patients with complete working capacity was practically unchanged; six patients recovered complete working capacity during this period, while three patients either relapsed, became unable to work because of other disease, or died.

No effect of the duration of the observation on the incidence of slight complaints was found, as shown below:

<i>Observation (months)</i>	<i>Number of patients with slight complaints</i>	<i>Total number of patients examined</i>
28-34	20	56
22-27	14	38

The effect of the duration of observation on the radiological findings is difficult to determine with certainty, as only 72 patients were examined radiologically after ten to fourteen months out of 94 patients seen at the last follow-up examination. Among these 72 patients, none showed deterioration between the two examinations, while nine of 17 patients with no change or with deterioration after twelve months showed improvement at the last examination. Fusion had developed after the twelve-months examination in six cases.

(c) *Age*

Data on working capacity have been presented in Table 10. The difference between the proportion of children with complete working capacity (95.2 per cent) and of adults (69.0 per cent) is 26.2 per cent. The difference is significant, as it is more than three times the standard error for this difference (± 8.1 per cent). A further breakdown of the age groups is presented in Table 17.

TABLE 17. *Effect of age on working capacity two to two-and-a-half years after operation in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Age Years	<i>Working capacity</i>			Total
	Complete	Partial	Incapacity for work, dead or not traced	
	Number	Number	Number	Number
0-4	18	—	2	20
5-14	22	—	—	22
15-24	13	1	5	19
25-44	23	5	7	35
45-59	4	—	—	4
Total	80	6	14	100

The effect of age on other relevant features is summarized below :

<i>Feature</i>	<i>Effect of age</i>	<i>Remarks</i>
Slight complaints	Less frequent in children (8 out of 42) than in adults (26 out of 58)	(See page 51). Caution is necessary in comparison of subjective information of this type
Recumbency	Shorter in children than in adults	See Table 7
Interval between operation and full resumption of work	Shorter in children than in adults	See Table 15
Fusion	More frequent in adults (68.8 per cent) than in children (40.5 per cent)	See Table 13; difference (28.3 per cent) nearly three times standard error (± 9.9 per cent)
Radiological improvement	None (adults 82.0 per cent, children 73.8 per cent)	See Table 13; difference (8.2 per cent) equal to standard error (± 8.2 per cent)
Recovery from paraplegia	None	See Table 11; small group only
Healing of sinus	None	See page 54; small group only
Wound complications	None; complications occurred in 8 children out of 42 and 12 adults out of 58	See page 60
Clinical kyphosis, and change in radiological kyphosis	Effect discussed below	See Figure 11, Table 16 and page 70

(d) *Duration of symptoms*

This had no effect either on the ensuing working capacity (Table 18) or the radiological findings (Table 19). The proportion of children with complete working capacity is the same within all groups, as is also the case with adults with a history of less than one year and upwards of five years. Twenty-four adults out of 32 (75.0 per cent) with a history of less than three years had complete working capacity, and 16 out of 26 adults (61.5 per cent) with a history of more than three years. The difference, 13.5 per cent, is insignificant (the standard error of this difference being ± 12.2 per cent).

Fifty-four lesions out of 67 (80.6 per cent) with a history of less than three years showed radiological improvement, and 27 out of 36 (75.0 per cent) with a history of upwards of three years.

TABLE 18. *Effect of duration of symptoms on complete working capacity two to two-and-a-half years after operation in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Duration of symptoms in years	Children		Adults	
	Complete working capacity	Total in group A	Complete working capacity	Total in group A
	Number	Number	Number	Number
Less than 1	17	19	4	7
1-3	14	14	20	25
3-5	3	3	7	11
5-17/18	6	6	9	15
Total	40	42	40	58

TABLE 19. *Effect of duration of symptoms on radiological findings two to two-and-a-half years after operation in 103 lesions in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Duration of symptoms in years	Radiological findings					Total
	Improvement	No change	Deterioration	Interpretation not possible	Dead or not traced	
	Number	Number	Number	Number	Number	
Less than 1	17	4	1	1	4 ¹	27 ¹
1-3	37 ¹	1	—	1	1	40 ¹
3-5	11	2	—	1	—	14
5-17/18	16 ¹	2	—	2	2	22 ¹
Total	81 ¹	9	1	5	7 ¹	103 ¹

¹ Three patients had double lesions; two of these showed improvement in both lesions and one patient had died.

(e) *Region of spine involved*

No effect was found on working capacity (Table 20) or on the radiological findings (Table 21). The proportion of children with complete working capacity was the same in patients with upper spinal lesions and those with lower spinal lesions; among adults the proportions were 17 out of 25 (68.0 per cent) and 22 out of 31 (70.9 per cent) respectively. Radiological improvement was found in 38 out of 53 (71.7 per cent) upper spinal lesions and 43 out of 50 (86.0 per cent) lower spinal lesions; the difference, 14.3 per cent, is insignificant (less than twice the standard error of this difference, ± 8.1 per cent). Fusion was found as follows:

Region of spine	Lesions with fusion		Total number of lesions
	Number	Per cent	
Children			
Upper spine	8	32.0	25
Lower spine	9	53.0	17
Adults			
Upper spine	19	68.0	28
Lower spine	23	70.0	33

The difference in children, 21.0 per cent, is insignificant (less than twice the standard error of this difference, ± 15.4 per cent).

The effect of the region of the spine involved on clinical kyphosis and changes in radiological kyphosis is discussed below.

TABLE 20. *Effect of region of spine involved on complete working capacity two to two-and-a-half years after operation in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Region of spine	Children		Adults	
	Complete working capacity	Total in group A	Complete working capacity	Total in group A
	Number	Number	Number	Number
Upper spine	23	25	17	25
Upper and lower spine	—	—	1	2
Lower spine	17	17	22	31
Total	40	42	40	58

TABLE 21. *Effect of region of spine involved on radiological findings two to two-and-a-half years after operation in 103 lesions in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Region of spine	Radiological findings					Total	Fusion
	Improve-ment	No change	Deterio-ration	Interpreta-tion not possible	Dead or not traced		
	Number	Number	Number	Number	Number	Number	Number
Upper spine	38 ¹	6	1	4	4 ¹	53 ¹	27
Lower spine	43 ¹	3	—	1	3 ¹	50 ¹	32
Total	81 ¹	9	1	5	7 ¹	103 ¹	59

¹ Three patients had double lesions; two of these showed improvement in both lesions and one patient had died.

(f) *Radiological grouping*

This had no effect on working capacity (Table 22) and hardly any on the radiological findings (Table 23). The proportion of children with complete working capacity is the same in all groups; among adults, 20 out of 29 with lesions in the radiological groups 1-2 had complete working capacity, and also 20 out of 29 lesions in groups 3-4. Thirty-four out of 38 lesions (89.5 per cent) in the radiological groups 1-2 showed radiological improvement, compared with 47 out of 65 lesions (72.3 per cent) in groups 3-4. The difference, 17.2 per cent, is on the borderline between insignificance and probability (being only slightly more than twice the standard error for this difference, ± 8.4 per cent).

TABLE 22. *Effect of radiological grouping on complete working capacity two to two-and-a-half years after operation in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Radiological group	Children		Adults	
	Complete working capacity	Total in group A	Complete working capacity	Total in group A
	Number	Number	Number	Number
1	1	1	1	1
2	8	8	19	28
3	19	21	14	21
4	12	12	6	8
Total	40	42	40	58

TABLE 23. *Effect of radiological grouping on radiological findings two to two-and-a-half years after operation in 103 lesions in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Radiological group	Radiological findings					Total
	Improvement	No change	Deterioration	Interpretation not possible	Dead or not traced	
	Number	Number	Number	Number	Number	
1	2	—	—	—	—	2
2	32	2	—	1	1	36
3	32	6	—	—	4	42
4	15 ¹	1	1	4	2 ¹	23 ¹
Total	81	9	1	5	7 ¹	103 ¹

¹ Three patients had double lesions; two of these showed improvement in both lesions and one patient had died.

(g) *Pulmonary and extrapulmonary complications*

There was no harmful effect of these on working capacity (Table 24); a higher proportion of adults with pulmonary tuberculosis, namely 18 out of 20 patients (90.0 per cent) had complete working capacity, as compared with adults without pulmonary tuberculosis, namely 22 out of 38 patients (58.0 per cent); the difference, 32.0 per cent, is more than twice the standard error (± 12.8 per cent), but it is reasonable to assume that this is explained by the influence of factors other than tuberculosis of the spine (see page 94). In two cases out of 21 with paraplegia, surgical damage occurred to the cord. Such damage did not occur in any of the 29 cases without paraplegia, operated upon in the same regions and in the same way.

TABLE 24. *Effect of pulmonary and extrapulmonary complications on complete working capacity two to two-and-a-half years after operation in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Condition	Children		Adults	
	Complete working capacity	Total in group A	Complete working capacity	Total in group A
	Number	Number	Number	Number
Pulmonary tuberculosis present	11	11	18	20
Pulmonary tuberculosis absent	29	31	22	38
Paraplegia present	7	8	8	13
Paraplegia absent	33	34	32	45
Sinus present	5	5	11	16
Sinus absent	35	37	29	42
Extrapulmonary tuberculosis present	2	3	7	10
Extrapulmonary tuberculosis absent	38	39	33	48

(h) *Anti-tuberculosis medication*

Previous medication had no harmful effect on the working capacity; of a group of 22 patients (nine children, 13 adults), all became completely able to work. The figures were too small to show whether previous medication had any beneficial effect. An increase in the pre-operative medication time from less than one month to one to six months affected neither the working capacity (Table 25) nor the

radiological findings (Table 26). The number of patients with pre-operative medication of six to twelve months, and from twelve months and upwards, is too small for appraisal, although brief reference to this aspect is made on page 116 and in Table 55.

A possible effect of the duration of the post-operative medication is difficult to assess, since it could be affected by the presence or absence of symptoms; patients without symptoms were likely to discon-

TABLE 25. *Effect of duration of pre-operative medication with INH and PAS on complete working capacity two to two-and-a-half years after operation in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Duration of pre-operative medication with INH and PAS	Children		Adults		Total	
	Complete working capacity	Total in group A	Complete working capacity	Total in group A	Complete working capacity	Total in group A
	Number	Number	Number	Number	Number	Number
Less than 1 month	13	14	9	16	22	30
1-6 months	23	24	24	34	47	58
6-12 "	2	2	3	3	5	5
12 months to 8 years	2	2	4	5	6	7
Total	40	42	40	58	80	100

TABLE 26. *Effect of duration of pre-operative medication with INH and PAS on radiological findings two to two-and-a-half years after operation in 103 lesions in 100 patients treated with anti-tuberculosis drugs in conjunction with radical operation (Group A)*

Duration of pre-operative medication with INH and PAS	Radiological findings					Total lesions
	Improve-ment	No change	Deterio-ration	Interpre-tation not possible	Dead or not traced	
	Number	Number	Number	Number	Number	
Less than 1 month	23 ¹	2	—	3	3	31 ¹
1-6 months	46	6	1	2	4 ¹	59 ¹
6-12 "	5	—	—	—	—	5
12 months to 8 years	7 ¹	1	—	—	—	8 ¹
Total	81 ¹	9	1	5	7 ¹	103 ¹

¹ Three patients had double lesions; two of these showed improvement in both lesions and one patient had died.

tinue medication (see page 46), while patients with persisting symptoms were likely to continue it. However, in a group of 18 patients (11 children and seven adults) with post-operative medication of less than twelve months, all the children and six out of the seven adults had complete working capacity.

(i) *Duration of recumbency*

Its possible effect is difficult to assess since the duration of recumbency also could be affected by the presence or absence of symptoms. Early ambulation appeared, however, to have no harmful effect on the final complete working capacity:

<i>Patients completely up and about within three months of operation</i>	<i>Number with complete working capacity</i>	<i>Total number in group</i>
Children	24	25
Adults	16	18

(j) *Hospitalization*

A short hospital stay had no effect on the working capacity; in a group of 28 patients (16 children and 12 adults) hospitalized for less than twenty-one days, all became completely able to work.

(k) *Recovery from paraplegia: effect of duration and type*

None of the patients had suffered from paraplegia for more than five years; within that limit, its duration had no effect on recovery, e. g. four out of five patients with paraplegia of three to five years' duration made a complete recovery.

The effect of the type of paraplegia was as follows:

<i>Type of paraplegia</i>	<i>Number with complete recovery</i>	<i>Total number in group</i>
Early	13	17
Late	3	4
Incomplete	9	10
Complete	7	11

(l) *Effect of various factors on clinical kyphosis and increase in radiological kyphosis*

Age, the region of the spine involved and the extent of the lesion (radiological grouping), all affect the clinical kyphosis. The data can be summarized as follows if, in the case of the three adults with double lesions, the more extensive of their lesions alone are taken into account (see also Fig. 11, p. 58).

Effect of age on clinical kyphosis:

Age group	Number with clinical kyphosis 3-4 after operation	Total number in group
Children	18	42
Adults	5	58

Effect of the region of the spine involved and of radiological grouping (extent of lesion) on clinical kyphosis:

Region of spine	Children		Adults	
	Number with clinical kyphosis 3-4	Total	Number with clinical kyphosis 3-4	Total
Upper spine	16	25	5	27
Lower spine	2	17	—	31

Radiological group

1-2	1	9	0	29
3	6	21	2	21
4	11	12	3	8

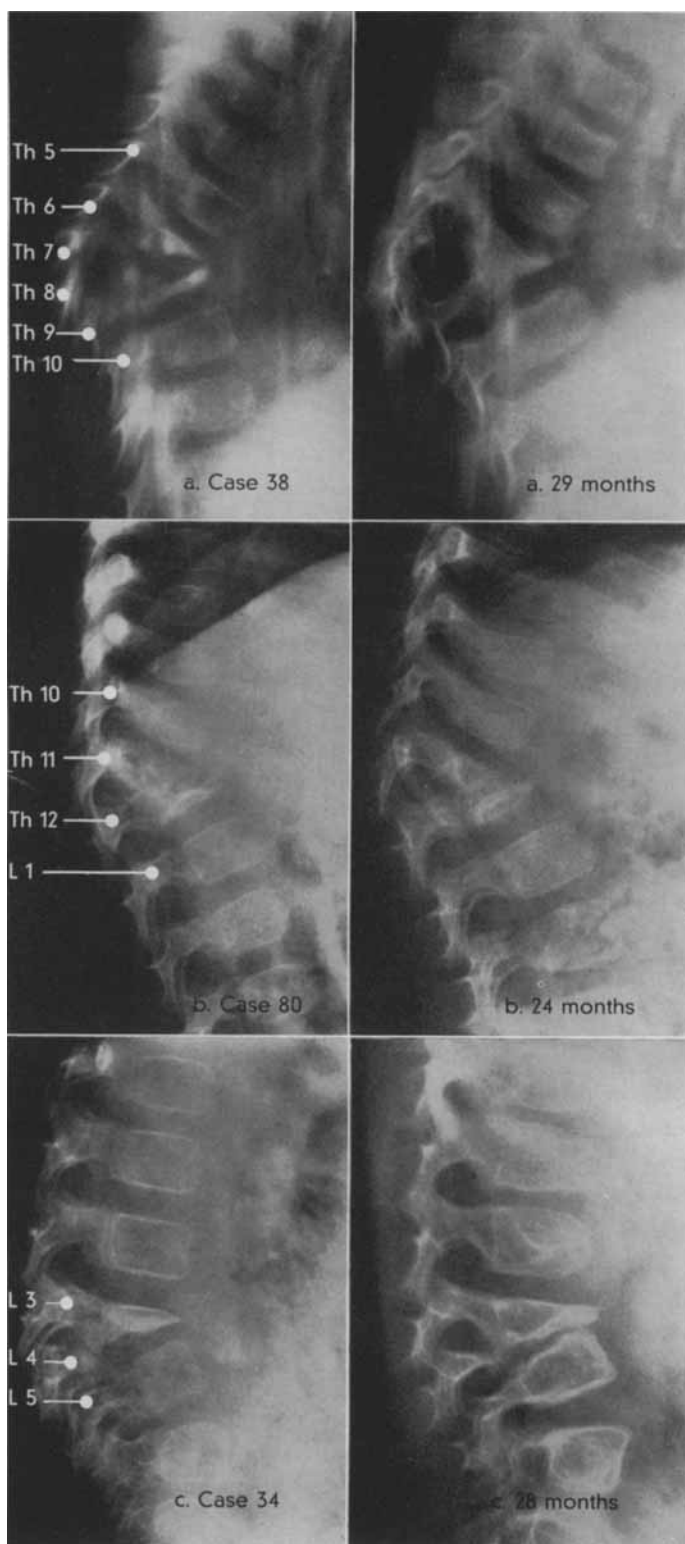
Increase in radiological kyphosis (Table 16) was also affected by age, region of the spine involved and extent of the lesions.

Effect of age on increase in radiological kyphosis:

Age group	Number with 10°-50° increase in radiological kyphosis	Total number of lesions
Children	17	42
Adults	10	61

Figure 12. Kyphosis was not affected by early ambulation

- a. Case 38 — Female 3 years, Th 5-9 in radiological group 4. Completely up and about within 1-3 months after operation. Clinical kyphosis 2 before operation and 2 after 29 months, radiological kyphosis 40° and 45°.
- b. Case 80 — Male 1 year and 9 months, Th 11-L 2 in radiological group 3. Completely up and about within 1 month after operation. Clinical kyphosis 2 before operation and 2 after 24 months, radiological kyphosis 25° and 35°.
- c. Case 34 — Female 2 years, L 1-S 1 in radiological group 3. Completely up and about within 1-3 months after operation. Clinical kyphosis 1 before operation and barely 1 after 28 months, radiological kyphosis 30° and 30°.



Effect of the *region of the spine involved* and of *radiological grouping (extent of lesion)* on increase in radiological kyphosis:

<i>Region of spine</i>	<i>Children</i>		<i>Adults</i>	
	<i>Number with 10°–50° increase in radiological kyphosis</i>	<i>Total</i>	<i>Number with 10°–50° increase in radiological kyphosis</i>	<i>Total</i>
Upper spine	16	25	7	28
Lower spine	1	17	3	33
<i>Radiological group</i>				
1–2	2	9	4	29
3–4	15	33	6	32

Twenty-three out of 27 lesions with an increase of 10°–50° were upper spinal lesions. In children, such increase was seen more often in the radiological groups 3–4, while the existence of any difference was uncertain in adults.

Early ambulation appeared to have no effect on the increase of radiological kyphosis (Fig. 12). In spite of the small numbers, the considerations are limited to lesions in the upper spine and in the radiological groups 3–4.

<i>Recumbency</i>	<i>Children</i>		<i>Adults</i>	
	<i>Number with 10°–50° increase in radiological kyphosis</i>	<i>Total</i>	<i>Number with 10°–50° increase in radiological kyphosis</i>	<i>Total</i>
Completely up and about within 3 months	8	13	1	6
Not completely up and about within 3 months	6	8	5	13

(m) *Failures*

All 12 patients with complete or partial working capacity because of their spinal disease at the last follow-up examination were adults; they had no other characteristic in common, nor was there any other feature which distinguished them from the other patients. They included members of both sexes, the symptoms had lasted from less than one to more than fifteen years; there were patients with upper spinal lesions and others with lower spinal lesions, in the radiological groups 2–4, without complications and with pulmonary or extrapulmonary complications. The ESR on admission for operation was in the range 9–114 mm/1 hr; pre-operative anti-tuberculosis medication had lasted from less than one month to two to three years. Many of these patients improved, e.g. the back pain disappeared, even if their working capacity was not fully restored.

Ambulatory Treatment with Anti-Tuberculosis Drugs, Group B

A total of 45 patients were originally allotted to this group, of whom four children and four adults were excluded as follows:

<i>Reason for exclusion</i>	<i>Number of patients</i>
Disappeared after first examination, not even known whether treatment started	6
Irregular medication and attendance for control examinations	1
Went to another hospital	1

The number of patients remaining for study in group B was therefore 37.

1. SURVEY OF PATIENTS

The *age distribution* is shown in Table 27; there were 18 children and 19 adults, and the age range was two to 58 years; there were 22 males and 15 females.

TABLE 27. *Age distribution of 37 patients receiving ambulatory treatment with anti-tuberculosis drugs for twelve months (Group B)*

Age Years	Patients	
	Number	Per cent
0-4	10	27.0
5-14	8	21.6
15-24	3	8.1
25-44	13	35.2
45-59	3	8.1
60 and above	—	—
Total	37	100.0

Duration of symptoms. The symptoms had lasted from three months to twenty years.

The data on the *region of the spine involved* were as follows:

<i>Region of spine</i>	<i>Number of lesions</i>	
	<i>Children</i>	<i>Adults</i>
Cervical	—	—
Cervico-dorsal	1	—
Dorsal	4	3
Dorso-lumbar	4	2
Lumbar	5	11
Lumbo-sacral	5	3
Sacral	—	—
Total:	19	19

There were 38 lesions among the 37 patients, as one child had a double lesion, namely a dorsal and a lumbo-sacral. The data are summarized in Table 28.

TABLE 28. *Region of spine involved in 37 patients receiving ambulatory treatment with anti-tuberculosis drugs for twelve months (Group B)*

Region of spine involved	Children		Adults		Total		
	Patients	Lesions	Patients	Lesions	Patients		Lesions
	Number	Number	Number	Number	Number	Per cent	Number
Upper spine	8	8	5	5	13	35.1	13 ¹
Upper and lower spine	1	2	—	—	1	2.7	2 ¹
Lower spine	9	9	14	14	23	62.2	23 ¹
Total	18	19	19	19	37	100.0	38 ¹

¹ The upper spine was involved in 14 lesions, and the lower spine in 24 lesions.

Vertebrae affected. The frequency with which different vertebrae were involved is shown in Fig. 13. The 18 children had a total of 78 vertebrae affected and the 19 adults a total of 64 vertebrae, giving an average of 4.3 for the children and 3.4 for the adults. Thirteen patients (35.1 per cent) had one or two vertebrae affected.

The distribution of *radiological groups* is shown in Table 29. Children had lesions in groups 3–4 more often than adults—13 out of 18 cases and six out of 19 respectively.

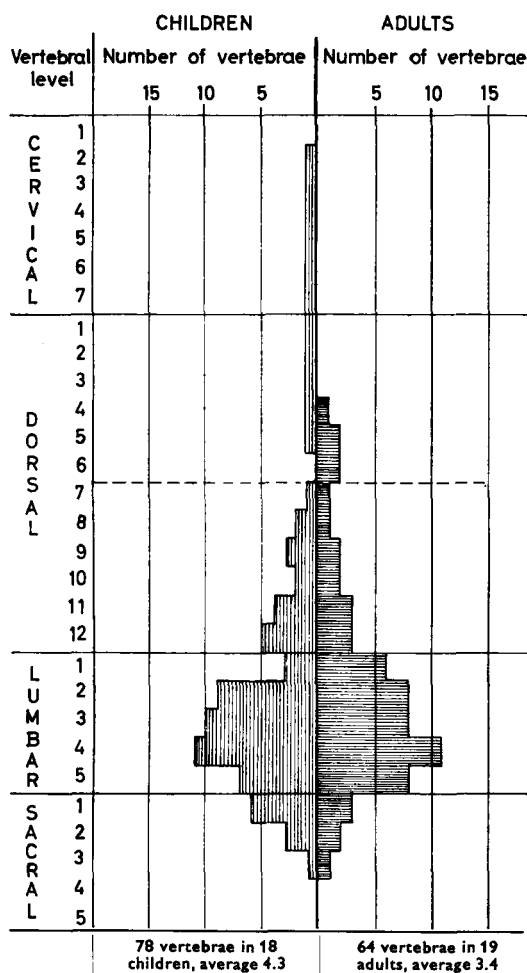


Figure 13. Vertebrae affected in 37 patients receiving ambulatory treatment with anti-tuberculosis drugs

TABLE 29. Radiological grouping of 37 patients receiving ambulatory treatment with anti-tuberculosis drugs for twelve months (Group B)

Radiological group	Children	Adults	Total	
	Number	Number	Number	Per cent
1	2	1	3	8.2
2	3	12	15	40.5
3	9	5	14	37.8
4	4	1	5	13.5
Total	18	19	37	100.0

Pulmonary and extrapulmonary complications. Twenty-one patients (57.0 per cent) were found to have 27 complications, two of the patients suffering from both pulmonary tuberculosis and extrapulmonary complications, and six patients suffering from more than one complication at the same time. Pulmonary tuberculosis, as determined by radiological examination, was found in six patients (16.2 per cent, one child and five adults); among these, one had extensive infiltrations and cavities. Extrapulmonary complications were found in 17 patients (46.0 per cent, eight children and nine adults):

<i>Complications</i>	<i>Number of complications</i>	
	<i>Children</i>	<i>Adults</i>
Pulmonary tuberculosis	1	5
Paraplegia	2	—
Sinus formation	5	8
Extraspinal tuberculosis of bones and joints	—	2
Tuberculosis of urogenital organs and lymph glands	1	1
Tuberculosis of pericardium	—	1
Paralysis of both lower extremities following earlier poliomyelitis	1	—

The *Mantoux tuberculin test* was positive in all 37 patients in the group.

Other tests. The urine was cultured for tubercle bacilli either once or several times: acid-fast bacilli were found in one case and not found in 31 cases, while no report was obtained in five cases.

The VDRL slide flocculation test for syphilis was carried out in all patients except children under 5–6 years of age; no seroreactors were found.

The data on the *period of observation* are as follows:

<i>Observation (months)</i>	<i>Number of patients</i>	<i>Cumulative total</i>
12	32	32
3–6	3	35
Dead	2	37

Thirty of the patients attended more or less regularly for control examinations at intervals of two to three months during the planned

treatment period of twelve months, while five patients disappeared after continuing treatment for three to six months. A search was made for these missing patients. Two were eventually traced and examined, bringing the total examined after twelve months to 32. Three could not be found, and two patients had died.

2. TREATMENT

Medication with anti-tuberculosis drugs. Previous medication had been received by six patients more than one month before treatment was begun by the hospital. Five patients had received medication for periods ranging from three years to two months, and in these patients there was no gap between this medication and the commencement of treatment by the hospital.

INH and PAS were given for the entire year in the dosages planned in 29 cases, INH alone in one case where PAS was not tolerated; five patients stopped treatment after three to six months and two died. SM was given in two cases admitted to the paediatric ward, for six weeks and sixteen weeks respectively, at the beginning of the treatment period.

Data on *recumbency*, estimated as the interval between the time when treatment was started by the hospital and when the patients were completely up and about, are given in Table 30; as seen from the Table, two patients were completely up and about from the start, the number increased to five after three to six months, and to 22 after twelve months.

In no case was *immobilization* by plaster-bed or body cast used; no restriction was placed on the patients' moving about.

Hospitalization. Apart from the two patients mentioned who were admitted to the paediatric ward, no patients in the group were hospitalized during the twelve-month investigation period. One of these two was admitted for attempted suicide consequent on paralysis from previous poliomyelitis, and one for tuberculous pericarditis; as stated above, hospitalization was for six weeks and sixteen weeks respectively. Tuberculosis of the spine was diagnosed after admission.

TABLE 30. *Recumbency in 37 patients receiving ambulatory treatment with anti-tuberculosis drugs for twelve months (Group B), based on the interval from beginning of treatment by the hospital to the time when the patients were completely up and about*

Recumbency	Children	Adults	Total	Cumulative total	
	Number	Number	Number	Number	Per cent
Up and about from the beginning	2	—	2	2	5.4
Less than 1 month	—	—	—	2	5.4
1-3 months	—	—	—	2	5.4
3-6 ,,	3	—	3	5	13.5
6-12 ,,	10	7	17	22	59.5
Partly or completely bedridden after 12 months:					
because of the spinal disease	—	9	9	32	86.5
because of other disease	1	—	1		
Dead, still bedridden	—	2	2	37	100.0
Not traced for examination	2	1	3		
Total	18	19	37	37	100.0

3. RESULTS OF TREATMENT

(a) *Clinical findings*

The data on back pain were as follows:

<i>Time</i>	<i>Patients with back pain</i>	<i>Patients without back pain</i>
Before treatment	37	0
After twelve months or when last seen	25	12

Ability to be up and about. The situation before treatment was the following:

<i>Condition</i>	<i>Number of patients</i>
Completely bedridden (includes one case where this was due to paralysis of both lower extremities following previous poliomyelitis)	31
Partly bedridden	4
Completely up and about	2

The changes during the twelve-month treatment period can be seen from Table 30, the essential features being that complete ability to be up and about was found in 22 patients (59.5 per cent); nine patients remained bedridden because of spinal tuberculosis and one owing to previous poliomyelitis; two had died while still completely bedridden and three could not be traced.

Working capacity. Four of the nine adult males were farmers or heavy labourers, while nine of the 10 adult females did housework; the remainder were sales personnel, office workers, students, etc. Their condition before treatment was started was as follows:

<i>Condition</i>	<i>Number of patients</i>
Complete incapacity to work	35
Complete working capacity	2

The incapacity had lasted from two–three months to five years.

The position at the end of the twelve-month treatment period is shown in Table 31. It can be seen that a total of 13 patients (35.1 per cent, 11 children and two adults) had complete working capacity; of these, six had no clinical symptoms or signs, except possibly kyphosis, while seven had slight complaints. There were, in addition, six patients (16.2 per cent) with partial working capacity. The condition of the remaining 18 patients can be seen from the Table.

TABLE 31. *Working capacity after twelve months in 37 patients receiving ambulatory treatment with anti-tuberculosis drugs (Group B)*

Working capacity	Children		Adults		Total	
	Num- ber	Per cent	Num- ber	Per cent	Num- ber	Per cent
<i>Complete</i>						
No clinical symptoms or signs	6	33.3	—	—	6	16.2
Slight complaints	5	27.8	2	10.5	7	18.9
<i>Partial</i>	4	22.2	2	10.5	6	16.2
<i>Incapacity</i>						
Due to the spinal disease: back pain and possibly sinus	—	—	12	63.2	12	32.4
Due to other disease: previous poliomyelitis	1	5.6	—	—	1	2.7
<i>Dead:</i>						
Still unable to work	—	—	2	10.5	2	5.4
<i>Not traced,</i> But unable to work when last seen	2	11.1	1	5.3	3	8.2
Total	18	100.0	19	100.0	37	100.0

Slight complaints were found in six patients (16.2 per cent).

General mobility was poor in 35 of the patients before treatment started; it was good in 19 patients at the end of the twelve-month treatment period.

The results of the examinations, where reported, showed that *tenderness* was originally present in 27 out of 32 patients; no tenderness was reported in 14 out of 30 at the end of the twelve-month treatment period.

Before treatment started, early and incomplete *paraplegia* was present in two children and had lasted for one month and four months respectively; both patients recovered completely within three to six months.

Sinus was present in 13 patients (five children and eight adults) before treatment started; in one case it healed within one month, and in seven cases within twelve months.

Information on *body weight* is too incomplete for a discussion of this feature to be of value.

Data on the *erythrocyte sedimentation rate* are given in Table 32, which shows that there was a fairly steady improvement during the twelve-month treatment period.

TABLE 32. *ESR in 37 patients receiving ambulatory treatment with anti-tuberculosis drugs (Group B)*

ESR mm/1 hr	Before treatment	After 6 months' treatment	After 12 months' treatment
	Number	Number	Number
1-9	5	6	11
10-19	5	9	9
20-29	4	3	6
30-49	8	4	2
50-	12	3	2
Dead, ESR influenced by pregnancy or intercurrent diseases, or not examined	3	12	7
Total number of patients	37	37	37

Data on *haemoglobin* are as follows:

<i>Time</i>	<i>Hgb</i> (gram per cent)	<i>Average Hgb</i> (gram per cent)
Before treatment	7.8-15.3	11.5
After twelve months	9.7-16.2	13.0

(b) *Radiological findings*

It will be recalled that there were originally a total of 38 lesions (see page 74). The position at the end of the twelve-month treatment period is shown in Table 33, from which it can be seen that *improvement* was found in 11 lesions (four children with five lesions and six adults with six lesions), representing 28.9 per cent of the total number of lesions, or 33.3 per cent of the 33 lesions which were examined.

TABLE 33. *Radiological findings after twelve months in 38 lesions in 37 patients receiving ambulatory treatment with anti-tuberculosis drugs (Group B)*

Findings	Children		Adults		Total	
	Number	Per cent	Number	Per cent	Number	Per cent
Improvement	5 ¹	26.3	6	31.6	11 ¹	28.9
No change	7	36.9	8	42.1	15	39.4
Deterioration	5	26.3	2	10.5	7	18.4
Interpretation not possible	—	—	—	—	—	—
Dead	—	—	2	10.5	2	5.3
Patients not traced	2	10.5	1	5.3	3	8.0
Total	19 ¹	100.0	19	100.0	38 ¹	100.0
Fusion	2	10.5	5	26.3	7	18.4

¹ One patient had a double lesion and showed improvement in both lesions.

Fusion was seen on the radiographs in two lesions before treatment and in seven lesions (18.4 per cent of the total number) by the end of the twelve months.

In only one case (a child) was complete working capacity found with no clinical symptoms or signs, as well as radiological improvement.

Pulmonary changes. The radiographs of the lungs showed the following:

<i>Condition before treatment</i>	<i>Number of patients</i>	<i>Condition after twelve months</i>
Pulmonary changes present	6	{Improvement 3 cases No change 2 cases Deterioration 1 case
Pulmonary changes absent	31	{No change 24 cases Not examined 7 cases

(c) *Interval between beginning of treatment and full resumption of work*

The relevant data are shown in Table 34, from which it can be seen that the number with complete working capacity increased from two (both children) before treatment, to three (all children) within six months, and to 13 (11 children, two adults) after twelve months.

TABLE 34. *Interval between beginning of treatment by the hospital and full resumption of work in 37 patients receiving ambulatory treatment with anti-tuberculosis drugs (Group B)*

Interval	Children		Adults		Cumulative total	
	Number	Per cent	Number	Per cent	Number	Per cent
No interval	2	11.1	—	—	2	5.4
Less than 3 months	—	—	—	—	2	5.4
3-6 months	1	5.6	—	—	3	8.1
6-9 "	6	33.3	—	—	9	24.3
9-12 "	2	11.1	2	10.5	13	35.1
Partial working capacity, incapacity, dead or not traced	7	38.9	17	89.5	37	100.0
Total	18	100.0	19	100.0	37	100.0

(d) *Kyphosis*

The clinical kyphosis after twelve months was as follows:

<i>Kyphosis group</i>	<i>Number of children</i>	<i>Number of adults</i>
0-2	11	15
3-4	5	1

The remaining five patients had either died or could not be traced. The child with a double lesion was classified as belonging to group 0-2.

The changes in radiological kyphosis after twelve months were as follows:

<i>Changes</i>	<i>Number of lesions</i>
Increase 10°-45°	10
Decrease	1
No change	22
Dead or not traced	5

The 10 lesions which showed an increase represented 26.3 per cent of all 38 lesions.

(e) *Complications during treatment*

The following complications developed:

<i>Complication</i>	<i>Number of patients</i>
Tuberculosis of female pelvic organs	1
Palpable abscess	3
Sinus formation	3
Intolerance to PAS	1

(f) *Failures and relapses*

Ambulatory treatment may be considered to have failed in the eight patients who were excluded because they disappeared after the first examination, failed to continue regular medication or went to another hospital (see page 73). Failure may also be considered to be the outcome in the case of 31 out of the 32 patients seen after twelve months who still had clinical and/or radiological symptoms and signs. Nothing can, of course, be said about the three patients who were not traced after twelve months.

There was a relapse in respect of back pain in one case, and in respect of sinus in another.

(g) *Mortality*

One patient committed suicide after three months; this was discovered when a visit was paid to his home after twelve months; his widow stated that the suicide was due to disappointment at not being admitted to hospital for operation. The spine condition was reportedly unchanged up to death.

A second patient developed fever after three months, with diarrhoea accompanied by the passage of blood, and died within two weeks; this information was obtained from the patient's family on a visit to her home after twelve months. In this case also the spine condition was reported to be unchanged up to death.

4. EFFECT OF VARIOUS FACTORS ON PROGNOSIS

Age had an effect on the recovery of complete working capacity, as shown in Table 31. The difference between the proportion in children (61.1 per cent) and in adults (10.5 per cent) is 50.6 per cent, which is more than three times the standard error for this difference (± 15.7 per cent). The groups are too small to justify further study of detail in regard to the effect of age on this feature.

The effect of age on certain other features is outlined below:

<i>Feature</i>	<i>Effect of age</i>
Recumbency	Shorter in children than in adults (see Table 30)
Interval between start of treatment and full resumption of work	Shorter in children than in adults (see Table 34)
Radiological improvement	None; (6 out of 16 followed-up lesions in adults, 5 out of 17 in children); (see Table 33)

<i>Feature</i>	<i>Effect of Age</i>
Fusion	More frequent in adults (5 out of 16 followed-up lesions) than in children (2 out of 17 lesions); (see Table 33)
Clinical kyphosis, and change in radiological kyphosis	Discussed below.

The following features had no effect either on working capacity or on radiological findings: *duration of symptoms, region of spine involved, radiological grouping, pulmonary and extrapulmonary complications*. It is not considered practicable to include in this presentation the data on which this statement is based.

Clinical kyphosis 3–4 and increase in radiological kyphosis of 10°–45° were seen more often in children than in adults, more often in upper spinal than in lower spinal lesions, and more often in lesions of the radiological groups 3–4 than the radiological groups 1–2, but the figures are too small to warrant detailed presentation.

Other Groups of Patients

In addition to the findings in study groups A and B, a brief account will be given in the following of certain observations on other patients which did not fall within the plan of the investigation, but which are nevertheless of interest in its context.

(a) Patients in group B operated upon after twelve months

As a consequence of persistent symptoms and signs, 30 patients in group B were advised to undergo operation after twelve months of ambulatory treatment with anti-tuberculosis drugs. In 17 of these cases there were both clinical and radiological symptoms and signs, in eight cases clinical only and in five cases radiological only. Of these 30 patients, 25 agreed to undergo operation. They are actually a group of patients who underwent operation after a long period of pre-operative medication, as distinct from those comprising group A.

These patients included the majority of those making up group B, on whom information has already been given. It will therefore be sufficient to mention that there were 13 children and 12 adults, and that there were no significant differences between these and group B as a whole in respect of duration of symptoms, region of the spine involved, number of vertebrae affected and radiological grouping. The duration of pre-operative medication with INH and PAS had lasted twelve to fifteen months in 22 cases, and fifteen months to eight years in three cases, while the pre-operative medication with SM, the operation, and the post-operative anti-tuberculosis medication were the same as for group A.

The post-operative observation period was about eighteen months, at the end of which 24 patients were followed up and one had died.

Gross pathology was found on operation in 14 cases and not found in 11 cases. The findings were as follows:

Pus and/or caseous material	9 cases
Granulation tissue and/or bone sand	11 cases
Bone and/or disc sequestrum	12 cases

Microbiological examination by culture gave the following results:

Acid-fast bacilli present	1 case
Acid-fast bacilli not present	22 cases
No examination	2 cases

The results of the histological examinations were as follows:

Tuberculous granulation tissue	13 cases
Chronic inflammation	2 cases
No pathological changes	10 cases

In two of the 11 cases without gross pathological changes at operation, tuberculous granulation tissue was found histologically; in these two cases, acid-fast bacilli were found in one and not in the other.

The correlation between the microbiological and histological findings is shown in Table 35.

TABLE 35. *Microbiological and histological findings in material removed by operation in 25 patients operated on after receiving ambulatory treatment with anti-tuberculosis drugs for twelve months*

Histological findings	Microbiological findings			Total
	Acid-fast bacilli		No examina- tion	
	Present	Not present		
	Number	Number	Number	
Tuberculous granulation tissue	1	12	—	13
Chronic inflammation without definite evidence of tuberculosis	—	2	—	2
Bone tissue, cartilage, fibrous tissue	—	8	2	10
Total	1 ¹	22 ¹	2	25

¹ By culture.

Other information with regard to these patients can be summarized as follows:

Post-operative recumbency	Less than one month: 12 cases
	Less than three months: 21 cases
Hospitalization	Within four to six weeks in 24 cases; average twenty-three days

Working capacity:	
Before operation	Complete working capacity, in spite of symptoms, in nine out of 13 children and two out of 12 adults
At last follow-up examination	Complete working capacity in all 13 children and six out of 12 adults, i.e. 19 patients (76.0 per cent) (see Table 52); a seventh adult had complete working capacity three to seven months after operation, when death occurred. ¹ Two adults had partial working capacity.
Slight complaints	In seven patients (two children, five adults), i.e. 28.0 per cent
Radiological results	Improvement in all 13 children and in nine adults out of 12, i.e. 22 patients (88.0 per cent) (see Table 53). No change in two patients, and one patient had died.
Interval between operation and full resumption of work	Complete working capacity within three months of operation in 11 out of 13 children and four out of 12 adults, i.e. 15 patients (60.0 per cent); within six months in all children and six adults

(b) *Patients in group B who continued ambulatory treatment without operation*

Seven patients in group B (three children, four adults) continued their ambulatory treatment. Five were followed up after a total period of observation of twenty-eight to thirty-four months, while two were not traced. Only one patient had complete, and three, partial working capacity. One was unable to work because of sequelae from previous poliomyelitis. Radiological improvement was found in four cases and no changes in one. Sinus had relapsed after two-and-a-half years in one patient; this was, incidentally, the only patient in group B who had been found after twelve months to be without clinical symptoms and signs and who showed radiological improvement.

(c) *Patients treated by radical operation without the addition of anti-tuberculosis drugs*

The author hesitated to use this method in a systematic way. When the first year of investigation gave an impression, however, that patients operated on following only a few days' pre-operative medication and with a few months' post-operative medication with anti-tuberculosis drugs apparently did as well as patients in whom medication lasted for longer periods, it was considered that a limited trial was justified

¹ This patient was stated, by her mother-in-law, to have died after a short illness accompanied by bloody sputum.

and would be of practical as well as of theoretical interest. Careful selection of patients was essential, and only those without symptoms and signs of other tuberculous manifestations could be treated in this way. Furthermore, anti-tuberculosis drugs would be given immediately if indicated by the post-operative course.

The operation was performed on a group of four children and four adults. The following is the relevant information:

Gross pathological changes at operation	8 cases
Acid-fast bacilli present by culture	6 cases
Acid-fast bacilli not present by culture	2 cases
Tuberculous granulation tissue found by histological examination	7 cases
Bone tissue and cartilage found by histological examination	1 case

The immediate post-operative course was characterized by persistence of back pain and, in some cases, by fever. For this reason, anti-tuberculosis medication was begun in five cases. In a sixth case, SM was left in the wound 'by mistake', and the parents of this patient also gave her SM for one month after discharge. A seventh patient died two days after operation; the cause of death was not known, and could not be discovered at autopsy. Only one patient, therefore, received no anti-tuberculosis drugs throughout the entire observation period.

The condition of the patients at the follow-up examination fifteen to eighteen months after the operation is summarized below:

Working capacity	Complete working capacity: two cases (one man, re-operated on after anti-tuberculosis medication started, and one child where SM was left in wound) Partial working capacity: three cases (includes patient who received no anti-tuberculosis drugs) Incapacity for work: two cases
Persistent back pain	Five cases
Sinus	Healing in one out of three cases
Radiological results	Improvement: none No change: six cases Deterioration: one case (the patient who received no anti-tuberculosis medication; this patient also showed radiological signs of disseminated pulmonary tuberculosis)

(d) *Patients who received no treatment*

Since not all patients advised to go elsewhere for treatment (see pages 27-28) in fact did so, a group of 10 such patients (five children and

five adults) were visited after a period of twelve months; these patients were chosen at random from among those living in Seoul. It appeared that three of these had received some treatment, while seven had remained untreated. Among these entirely untreated patients, five were unable to work and two had gradually become worse and died, reportedly because of their spinal disease.

Comparison of Results of Treatment

- 1. Group A and Earlier Reports**
- 2. Group A and Group B**
- 3. Group A and Other Groups of Patients**

Group A and Earlier Reports

(a) *Basis of comparison*

The justification for the use of a treatment method depends ultimately on the extent to which the results compare favourably with those obtained by other methods; a comparison of the results of the treatment methods used was therefore an essential feature of the present investigation. Ideally, various methods of treatment should be administered to fully comparable study and control groups of patients at the same time. The nature of the study material and the limitations of time and ward capacity made this impossible. A comparison was therefore attempted between results actually obtained and those published in earlier reports, notwithstanding the recognized limitations of this approach, including difference in the nature of the patient materials and the fact that the patients were treated at different times, in different places and by different surgeons. In these circumstances it is essential that:

- (i) the criteria used for the assessment of the results of treatment are defined and reasonably reliable;
- (ii) the size of the patient material and the proportion of followed-up cases are adequate, and the period of observation sufficiently long;
- (iii) the composition of the patient material and the environmental conditions are not biased so that the group used in the investigation is at an advantage as compared with patient material in earlier reports;
- (iv) the method used for the computation of treatment results is not biased in favour of the treatment method under investigation.

Assessment of results of treatment. Experience has shown that a definite statement to the effect that tuberculosis of the spine has actu-

ally healed is difficult to make. Following years of quiescence, the process may flare up. In the present report the term 'healed' is therefore not used, and the results of treatment were assessed on the basis of clinical and radiological findings within their limits of difference in interpretation. Certain factors can be clearly measured, such as body weight, ESR and Hgb. However, these can at most indicate improvement, but not healing. In addition, in the present investigation, these factors are of limited value owing to certain practical difficulties arising from local conditions. Thus, while it was possible to measure the body weight on admission to the hospital ward and at the last follow-up examination, this could not be done during all control examinations, since it was not possible to persuade patients to undress completely at the out-patient clinic. Furthermore, the values of ESR and Hgb were probably also affected by the infestation of patients with parasites (page 99). Also, while an ESR of 1-9 mm/1 hr was found in cases with florid tuberculosis of the spine, more than 50 mm/1 hr could be observed in cases with no other symptoms or signs of disease.

Other objective signs include the healing of a sinus, the disappearance of paralysis, and the normalization of the reflexes in a paraplegic patient. But these apply only to patients in whom these signs were originally present, and do not prove healing either. Improvement in mobility and disappearance of tenderness cannot be precisely measured. To the patient the disappearance of pain appears as a most important indication of 'healing', but is difficult to assess objectively apart from the fact that some patients do not have pain.

Working capacity is an important criterion of the state of health of an individual. As a rule, full working capacity indicates good health, and when an individual becomes fully capable of working after having been temporarily incapacitated because of disease, this is an indication of improved health. The criterion has therefore been regarded as important in the assessment of the clinical results in the present investigation, in spite of the fact that an evaluation of working capacity itself cannot be fully objective. On the contrary, it is affected by the patient's personality as well as by factors other than the tuberculosis of the spine. It was mentioned that two patients in group A had complete working capacity before operation (see page 51), and two patients in group B also had complete working capacity before treatment started (see page 79). In the present investigation, it is believed that the poor economic situation of the patients could have forced the adult patients back to work rather early; on the other hand, prevailing extensive unemployment would possibly ensure that any employee whose work was not completely satisfactory would be dismissed.

The criteria adopted for the assessment of radiological improvement have been described on page 36; it will be remembered that such assessment is subject to differences in examination technique and to differences in the interpretation of the radiographs, and that pathological changes may be present in a vertebra without this being apparent from the radiograph.

The assessment of kyphosis and of differences in kyphosis by radiological examination does not give precise results. The angle which appears on the film is affected by the position of the patient in relation to the direction of the radiological beam; it may be different in a plain radiograph and a tomograph taken on the same day; it may be difficult to determine, e.g. in cervico-dorsal lesions and in extensive lesions (Fig. 14). Changes of kyphosis of less than 10° , or perhaps even 15° , should be regarded with caution.

It must be concluded that very few strictly objective clinical and radiological criteria exist for the assessment of the results of treatment, and that they cannot be expected to be present in all patients. The best criteria available require the use of judgment in their application, and caution must therefore be exercised in the comparison of data in different investigations.

Size of the patient material and period of observation. Group A included 100 patients. The follow-up examination of April-June 1960 was made difficult by the fact that it happened to coincide with a national revolution. Nevertheless, 84 patients were examined while, in the follow-up examination of September-November 1961, 94 patients (94.0 per cent) were seen, two were not traced, and four had died.

The period of observation was two to two-and-a-half years, which is adequate for the assessment of the short-term results of treatment and for the detection of serious immediate complications. It is not adequate to assess the long-term results, although an indication of what these are likely to be is given by the fact that there was little change as between twelve months and two to two-and-a-half years after operation. In addition, 44 patients were examined after three to three-and-a-half years by the author's successor in Seoul,¹ and essentially the same results were found as those observed by the author after two to two-and-a-half years. It may be mentioned in this connexion that FELLÄNDER (1954), HODGSON & STOCK (1960) and DEBEYRE (1961) reported that they found little change after the first one or two years following radical operation. It is also relevant that many reports on the usual method of treatment by radical operation in conjunction

¹ Dr. H. Thrap-Meyer.

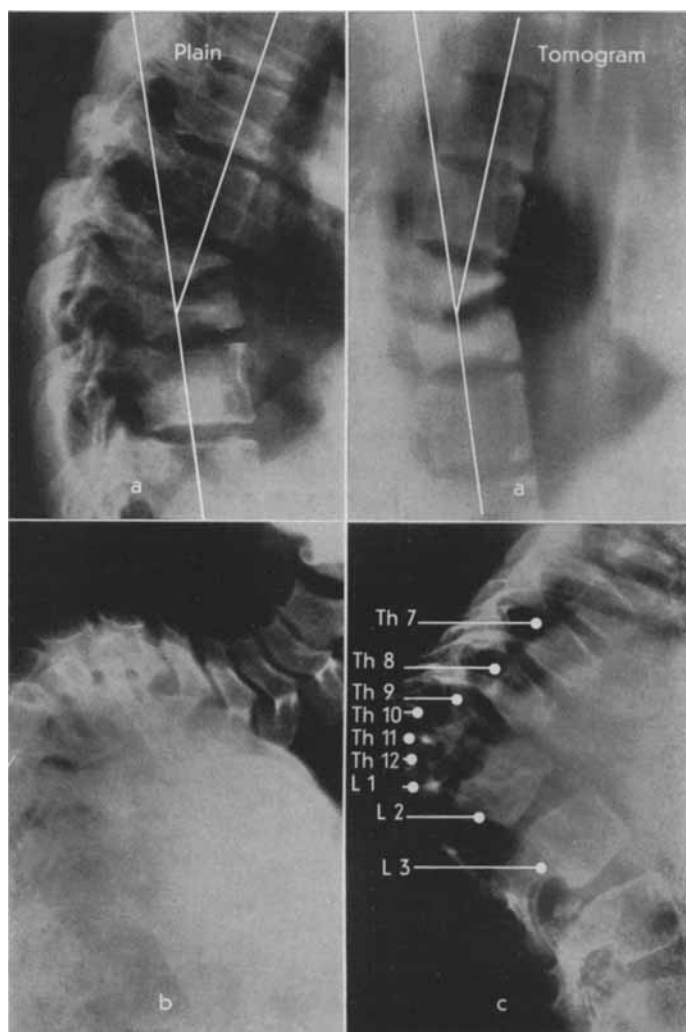


Figure 14. The difficulty of exact assessment of radiological kyphosis
a. The angle may vary as between a plain radiograph and a tomogram taken on the same day.
b. The axis may be difficult to distinguish in cervico-dorsal lesions.
c. The axis may be difficult to distinguish in extensive lesions.

with anti-tuberculosis drugs are based on periods of observation not much longer than those in the present investigation.

It appeared that the size of the patient material and the proportion of patients followed up were adequate for conclusions to be drawn. The period of observation was long enough for the assessment of the short-term results of treatment, but caution is needed in prognosticating the long-term results.

Composition of patient material and environmental conditions. In the present investigation, the patient group included 42.0 per cent children. In earlier reports the percentage of children varied, FELLÄNDER (1954) e.g. reported 11.0 per cent under the age of 20 and KASTERT (1957) reported 12.8 per cent up to 15 years old, while HODGSON & STOCK (1960) reported 69.0 per cent up to 10 years old, and KONSTAM & BLESOVSKY (1962) reported 64.2 per cent up to 12 years. Since the distribution between children and adults thus varied between the present investigation and in earlier reports, and since the prognosis in respect of working capacity in the present investigation is better for children than for adults, while for kyphosis worse, it would have been of value to deal separately with children and adults. This was not possible since some of the earlier reports do not distinguish between children and adults.

It was shown in the present investigation that the region of the spine involved, the extent of the lesion (radiological grouping) and the presence of pulmonary and extrapulmonary complications had no effect on the ensuing working capacity or on the radiological findings. However, the patients in group A did not appear to differ in any important ways from those dealt with in earlier reports in respect of the region of the spine involved (see page 42). There was a difference with regard to the extent of the lesion, since the average number of vertebrae affected in this investigation was 4.2, compared with 2.4–3.0 in the reports on the orthodox method of treatment (ALVIK 1949, HALLOCK & JONES 1954 and BAKALIM 1960), and 2.3–2.5 in reports on the usual method of treatment by radical operation in conjunction with anti-tuberculosis drugs (FELLÄNDER 1954, KASTERT 1957); in one report it was 3.4 (HODGSON & STOCK 1960). The proportion of patients with 1–2 vertebrae affected was 28.0 per cent in the present investigation, compared with 52.0–79.8 per cent in earlier reports. It is noted that many of these reports date back to a time when tomography was not used.

The proportion of patients with paraplegia in group A (21.0 per cent) was high as compared with most of the reported rates: 4.5–10.8 per



Figure 15. *Examples of housing conditions in South Korea at the time of the investigation*

cent (ALVIK 1949, FELLÄNDER 1954, KASTERT 1957, CAUCHOIX *et. al.* 1961), while 35.0 per cent was reported by HODGSON & STOCK (1960).

The present investigation was carried out in Seoul, South Korea, which is located on about 37.5° N. The average temperature varies between $25-26^{\circ}\text{C}$ in the summer and -8° to -12°C in the winter. The houses were small, overcrowded and dark. As a result of the war, people also lived, at the time of the investigation, in tents and shacks (Fig. 15). Windows were small, and semi-transparent rice paper was often used instead of glass. People slept on mattresses on the floor, and these were put away during the day when the room was used for ordinary domestic purposes. Isolation and rest at home were practically impossible. The houses were poorly heated, and diseases of the upper respiratory tract were common during the cold season.

The patients were of Mongolian race, and more than 90.0 per cent belonged to the poorest classes of the population. The monthly net income of a labourer was stated to be about 23,000 *hwan*,¹ while the minimum cost of living for an average family of 5.2 required 35,000 *hwan* (TAK 1960). Unemployment was widespread, the proportion being said to be 30.0 per cent of the adult male population. A social security system was only at the planning stage.

¹ 1,000 *hwan* equalled US \$1.00 at the official rate of exchange in 1960.

Food consisted mainly of steamed rice with some additional vegetables and fish; meat was generally beyond the means of most of the population, while milk and milk products were practically unknown (IM 1960).

A large proportion (80.0–90.0 per cent) of the population were infested with one or more parasites, among which the most common were *Clonorchis sinensis*, *Ankylostoma duodenale*, *Ascaris lumbricoides*, *Trichuris trichiura* and *Trichostrongylus orientalis* (USAID and WHO 1962). 'Malnutrition caused by lack of animal protein, fats, the vitamin B group, and ashes, is a national malaise' (SONG 1960, page 312). It is of interest in this connexion that the average weight of patients before operation was 49.5 kg (see page 54), while the average height of the Korean male is 161–169 cm (KIM KISU 1960).

Little can be said regarding the type and virulence of the tubercle bacillus in this investigation as compared with earlier reports from other parts of the world, nor regarding any possible effect of race and climate on the tuberculous process or on prognosis. It has, however, been pointed out that the morbidity of pulmonary tuberculosis in the population was high (see page 24). The proportion of cases with necrosis, as shown by histological examination in group A, was 64.0 per cent of the total and 86.5 per cent of those with tuberculous granulation tissue, the last figure being in agreement with those of KASTERT (1957), namely 85.66 per cent for his own material and 81.7–89.1 per cent for that of other writers. The further course in the few patients treated by radical operation without anti-tuberculosis drugs, and in the few patients who remained untreated and were followed up, does not suggest that tuberculosis of the spine runs a particularly favourable course in South Korea. Further, some of the earlier reports originate from countries close to South Korea: Hong Kong, Japan, Singapore (HODGSON *et al.* 1956–63, KONDO & YAMADA 1951–61, KATAYAMA *et al.* 1956, 1961, and KARLÉN 1959).

It appeared that the composition of the patient material and the environmental conditions did not place the study group in the investigation at an advantage as compared with other patient material. The high proportion of children should, however, be borne in mind.

The results of treatment were computed on the basis of the total number of patients in the investigation. The same procedure was used also in some earlier reports, but in others the evaluation was based on the number of surviving patients only, or on the number of patients actually followed up. It is concluded, therefore, that the method of computation used does not introduce any bias in favour of the treatment under investigation.

(b) *Comparison of results of treatment*

A detailed comparison of the results obtained with the treatment under investigation with those published in earlier reports is presented in Tables 36–45. This comparison shows the following:

<i>Feature</i>	<i>Comparison of group A with earlier reports</i>
Recumbency	Shorter in group A (see Table 36)
Hospitalization	Shorter in group A (see Table 37)
Working capacity	Findings compare favourably (see Table 38)
Slight complaints	Frequency compares favourably (see Table 39)
Recovery from paraplegia	Frequency compares favourably (see Table 40)
Radiological improvement	Frequency compares favourably (see Table 41)
Fusion	Frequency compares favourably (see Table 41)
Interval between operation and full resumption of work	Shorter in group A (see Table 42)
Clinical kyphosis	Findings compare favourably (see Table 43)
Change in radiological kyphosis	Findings compare favourably (see Table 44)
Healing of sinus	No comparison made; not often discussed in earlier reports
Operative mortality	Findings compare favourably (see Table 45)

TABLE 36. *Recumbency in the present investigation (Group A) and in earlier reports; estimated in Group A as interval between operation and time when patients were completely up and about, but in earlier reports probably estimated as interval from beginning of treatment or operation to time when patients started to be up and about*

Group A ¹	Orthodox treatment ²	Radical operation ³
Less than 3 months in 43.0 per cent	13 months–	Most authors
Less than 6 months in 71.0 per cent	5 years	3–8 months

¹ See Table 7.

² See pages 10 and 12.

³ See page 16.

TABLE 37. *Duration of hospitalization in the present investigation (Group A) and in earlier reports*

Group A ¹	Orthodox treatment ²	Radical operation ³
Up to 30 days in 57.5 per cent Up to 40 days in 71.2 per cent Up to 60 days in 88.3 per cent Average: 35 days	13 months–5 years	Most authors 4–6 months

¹ See Table 8.

² See pages 10 and 12.

³ See page 16.

TABLE 38. *Working capacity in the present investigation (Group A) and in earlier reports*

Working capacity	Group A ¹	Orthodox treatment ²	Orthodox treatment with anti-tuberculosis drugs ³	Ambulatory treatment ⁴	Radical operation ⁵
	Per cent	Per cent	Per cent	Per cent	Per cent
Complete	80.0	29.1–44.0	93.0	86.0	53.3–95.7
Complete and partial	86.0	36.5–73.0	—	?	68.0–95.7

¹ See Table 10.

² See page 11.

³ See page 12.

⁴ See page 12.

⁵ See Table 1.

TABLE 39. *Slight complaints in the present investigation (Group A) and in earlier reports*

Group A ¹	Orthodox treatment ²	Radical operation ³
Per cent	Per cent	Per cent
34.0	14.7–73.4	11.0–32.3

¹ See page 51.

² See page 11.

³ See page 17.

TABLE 40. *Complete recovery from paraplegia in the present investigation (Group A) and in earlier reports*

Reports	Complete recovery	Total in group
	Number	Number
<i>Group A</i> ¹	16	21
<i>Orthodox treatment</i> ²		
Alvik (1949)	10	23
Griffiths <i>et al.</i> (1956)	80	141
Kaplan (1959)		
without anti-tuberculosis drugs	18	31
with anti-tuberculosis drugs	24	29
<i>Ambulatory treatment</i> ³		
Konstam & Blesovsky (1962)		
without operation	26	28
with operation	25	28
<i>Radical operation</i> ⁴		
Kastert (1957)	11	19
Hodgson & Stock (1960)	26	35
Cauchoix <i>et al.</i> (1961)	12	22
Riskó & Novoszel (1963)	10	10

¹ See Table 11.

³ See page 13.

² See pages 11 and 12.

⁴ See page 17.

TABLE 41. *Radiological findings in the present investigation (Group A) and in earlier reports*

Radiological findings	Group A ¹	Orthodox treatment ²	Orthodox treatment with anti-tuberculosis drugs ³	Ambulatory treatment ⁴	Radical operation ⁵
	Per cent	Per cent	Per cent	Per cent	Per cent
Improvement/Healing	78.6 ⁶	35.0-88.0	?	?	52.0-94.0
Fusion	57.2	48.09-52.5	56.1	74.0	38.0-94.0

¹ See Table 13.

² See page 11.

³ See page 12.

⁴ See page 13.

⁵ See Table 2.

⁶ Computed on the basis of the total number of lesions; if computed only on the basis of the lesions examined at the follow-up examination and whenever interpretation of radiographs was possible, the percentage would be 89.0.

TABLE 42. *Interval between operation and full resumption of work in the present investigation (Group A) and the interval in earlier reports between beginning of treatment, fusion operation or radical operation and resumption of work*

Interval Months	Group A ¹	Orthodox treatment ²	Ambulatory treatment ³	Radical operation ⁴
	Per cent	Per cent	Per cent	Per cent
Less than 6	45.0	—	—	13.0
Less than 12	74.0	50.0	59.0	43.0

¹ See Table 15.

² See page 11. In addition, *Alvik* (1949) reported resumption of work within 6 months after discharge from hospital in 24.46 per cent, and within 12 months in 58.16 per cent.

³ See page 13.

⁴ See page 19. In addition *Wilkinson* (1957) reported a period of 12 months between operation and resumption of work, and *Cauchoir et al.* (1961) a period of 16 months.

TABLE 43. *Clinical kyphosis in Groups 3-4 in the present investigation (Group A) and 'Moderately large' or 'Very large' in earlier reports*
By age

	Group A ¹	Orthodox treatment ²	
		Bierring (1934)	Alvik (1949)
Observation in years	2-2½	— 12	2-10
<i>Children</i>			
Total in group	42	17	22
With kyphosis: Number	18	8	13
Per cent	42.9	47.0	59.1
<i>Adults</i>			
Total in group	58	59	251
With kyphosis: Number	5	10	43
Per cent	8.6	17.0	17.1

By region of spine involved

	Group A ¹	Orthodox treatment ²
		Alvik (1949)
Observation in years	2-2½	2-10
<i>Upper spinal lesions:</i>		
Total in group	52	118
With kyphosis: Number	21	44
Per cent	40.4	37.3
<i>Lower spinal lesions:</i>		
Total in group	48	155
With kyphosis: Number	2	12
Per cent	4.1	7.7

¹ See Figure 11. ² See page 11.

TABLE 44. *Changes in radiological kyphosis in the present investigation (Group A) and in earlier reports*

Changes	Group A ¹		Orthodox treatment ²				Ambulatory treatment ³		Radical operation ⁴	
			Hallock & Jones (1954)		Bakalim (1960)		Konstam & Blesovsky (1962)		Cauchoix <i>et al.</i> (1961)	
	Num-ber	Per cent	Num-ber	Per cent	Num-ber	Per cent	Num-ber	Per cent	Num-ber	Per cent
Increase between 10° and 30°	18	—	20	—	7	—	59	—	—	—
30° or more	9	—	11	—	4	—	18	—	—	—
Increase 10° or more	27	26.2	31	39.2	11	18.6	77	37.2	—	25.0
Decrease	1	1.0	3	3.8	—	—	8	3.8	—	—
No change	68	66.0	45	57.0	48	81.4	120	58.0	—	74.0
Patients dead or not traced	7	6.8	—	—	—	—	2	1.0	—	1.0
Total number of lesions	103	100.0	79	100.0	59	100.0	207	100.0	211	100.0

¹ See Table 16.

² See pages 11 and 12.

³ See page 13. The numbers are approximations and have been estimated on the basis of these investigators' histogram.

⁴ See page 19.

TABLE 45. *Operative mortality in the present investigation (Group A) and in earlier reports*

Group A ¹	Radical operation ²
Per cent	Per cent
1.0	0.0-9.9

¹ See page 61.

² See page 19.

Group A and Group B

(a) *Basis of comparison*

The criteria used for the assessment of the results of treatment were the same for groups A and B. The assessment was made personally by the author in both instances. The patients were drawn from the same population, with the same environmental conditions, and were treated in the same hospital during the same period. The size of the groups and the proportion of followed-up cases were as follows:

<i>Group</i>	<i>Original number of patients</i>	<i>Followed-up patients</i>	
		<i>Number</i>	<i>Per cent</i>
A	100	94	94.0
B	37	32	86.5

Circumstances prevented the enlargement of group B, as already discussed; the proportion of cases followed up is considered to be adequate particularly since information about the condition before death was available also in the 4 patients in group A and 2 patients in group B who died. The period of observation was different in the two groups, but it has been shown (see page 61) that the clinical findings in group A were essentially the same after twelve months and at the last follow-up examination, and that the radiological findings had probably changed to only a small extent.

The composition of the patient materials was essentially the same in the two groups. The age distribution was as follows:

<i>Age-group</i>	<i>Group A</i>		<i>Group B</i>	
	<i>Number</i>	<i>Per cent</i>	<i>Number</i>	<i>Per cent</i>
Children	42	42.0	18	48.6
Adults	58	58.0	19	51.4

It has been shown that various other factors had no effect or a very uncertain effect on the results of treatment for either group. These factors will nevertheless be considered in the following in order to

emphasize the essential similarity of the groups. The duration of symptoms was as follows:

<i>Duration of symptoms in years</i>	<i>Group A</i>		<i>Group B</i>	
	<i>Number</i>	<i>Per cent</i>	<i>Number</i>	<i>Per cent</i>
Less than 3	65	65.0	22	59.5
More than 3	35	35.0	15	40.5

The region of the spine involved was as follows:

<i>Region of spine</i>	<i>Group A</i>		<i>Group B</i>	
	<i>Number</i>	<i>Per cent</i>	<i>Number</i>	<i>Per cent</i>
Upper spine	50	50.0	13	35.1
Upper and lower spine	2	2.0	1	2.7
Lower spine	48	48.0	23	62.2

There were apparently more lesions located in the upper spine in group A than in group B, and fewer lesions in the lower spine in group A than in group B. The difference in upper spinal lesions was thus 14.9 per cent. This difference is insignificant (being less than twice the standard error for this difference, ± 9.6 per cent).

There were more patients with lesions in radiological groups 1-2 in group B (48.7 per cent) than in group A (38.0 per cent), but the difference, 10.7 per cent, is insignificant (being only slightly higher than the standard error for this difference, ± 9.4 per cent). The distribution was as follows:

<i>Radiological group</i>	<i>Group A</i>		<i>Group B</i>	
	<i>Number</i>	<i>Per cent</i>	<i>Number</i>	<i>Per cent</i>
1	2	2.0	3	8.1
2	36	36.0	15	40.6
3	42	42.0	14	37.8
4	20	20.0	5	13.5

A larger difference might have been expected in view of the procedure adopted of allocating to group A all patients who, at the initial interpretation of the radiographs, were believed to have four or more vertebrae affected (see page 27).

Pulmonary and extrapulmonary complications were found as follows:

<i>Complications</i>	<i>Group A</i>		<i>Group B</i>	
	<i>Number</i>	<i>Per cent</i>	<i>Number</i>	<i>Per cent</i>
Pulmonary tuberculosis	31	31.0	6	16.2
Extrapulmonary complications	48	48.0	17	46.0

There were more patients with paraplegia in group A (21 out of 100 patients) than in group B (two out of 37). The explanation for this difference is probably that patients with paraplegia had four or more

vertebrae affected in 20 out of the total of 23 cases. They were consequently allocated to group A (see page 27).

It is concluded that a comparison of the results of treatment in groups A and B is justified, and that any differences found should mainly be due to differences in the treatment. These differences consisted in the use of radical operation in group A, with accompanying hospitalization of an average duration of thirty-five days, medication with SM during this period, and with training and instruction in exercises. The use of other anti-tuberculosis drugs and the omission of enforced recumbency and of immobilization were the same in both groups. It would have been of interest to limit the difference in treatment solely to the inclusion or omission of the operation, but time and ward capacity did not permit the hospitalization of group B patients even for thirty-five days.

(b) Comparison of results of treatment

A detailed comparison of some of the results of treatment in group A and in group B is presented in Tables 46–51. The comparison shows the following:

<i>Feature</i>	<i>Comparison of group A with group B</i>
Recumbency	Shorter in group A (see Table 46)
Working capacity	Better in group A (see Table 47). The difference in complete working capacity among children (34.1 per cent) and adults (58.5 per cent) is significant, being more than three times the standard error for these differences (± 10.0 and ± 13.1 per cent respectively).
Back pain disappeared, mobility improved, tenderness ceased, sinus healed	More often in group A (see Table 48), but observations of limited value as criteria for comparison
Recovery from paraplegia	No comparison justified as group B included only two cases (see Table 48)
Radiological improvement	More often in group A (see Table 49); the difference (49.7 per cent) is significant, being more than three times the standard error for this difference (± 9.0 per cent).
Fusion	More often in group A (see Table 49); the difference (38.8 per cent) is significant, being more than three times the standard error for this difference (± 9.5 per cent).
Interval between operation or beginning of treatment and full resumption of work	Shorter in group A (see Table 50).

Feature

Comparison of group A with group B

Change in radiological kyphosis

The same (see Table 51); group B too small for division of patients into children and adults and of lesions into upper spinal and lower spinal; the distributions were, however, nearly the same in group A and in group B.

TABLE 46. *Recumbency in Group A and Group B*

Recumbency	Group A ¹		Group B ²	
	Number	Per cent	Number	Per cent
Less than 3 months	43	43.0	2	5.4
Less than 6 months	71	71.0	5	13.5
Less than 12 months	89	89.0	22	59.5

¹ See Table 7.

² See Table 30.

TABLE 47. *Working capacity in Group A and Group B*

Working capacity	Children				Adults			
	Group A ¹		Group B ²		Group A ¹		Group B ²	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Complete	40	95.2	11	61.1	40	69.0	2	10.5
Partial	—	—	4	22.2	6	10.3	2	10.5
Total	40	95.2	15	83.3	46	79.3	4	21.0

¹ See Table 10.

² See Table 31.

TABLE 48. *Back pain, general mobility, tenderness, healing of sinus and recovery from paraplegia in Group A and Group B*

Feature	Group A ¹		Group B ²	
	Number	Per cent	Number	Per cent
No back pain	94	94.0	12	32.4
General mobility good	84	84.0	19	51.3
No tenderness ³	72	87.8	14	46.7
Sinus healed	19	90.5	7	53.8
Complete recovery from paraplegia	16	76.2	2	100.0

¹ See pages 50–54.

² See pages 78–80.

³ Percentages computed on the basis of patients examined for tenderness.

TABLE 49. *Radiological findings in Group A and Group B*

Findings	Group A ¹		Group B ²	
	Number	Per cent	Number	Per cent
Improvement	81	78.6	11	28.9
No change	9	8.7	15	39.4
Deterioration	1	1.0	7	18.4
Interpretation not possible, patients dead or not traced	12	11.7	5	13.3
Total number of lesions	103	100.0	38	100.0
Fusion	59	57.2	7	18.4

¹ See Table 13.² See Table 33.TABLE 50. *Interval between operation in Group A and between beginning of treatment by hospital in Group B, and full resumption of work*

Interval Months	Children				Adults			
	Group A ¹		Group B ²		Group A ¹		Group B ²	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Less than 3	13	31.0	2	11.1	2	3.4	—	—
Less than 6	32	76.2	3	16.7	13	22.4	—	—

¹ See Table 15.² See Table 34.TABLE 51. *Changes in radiological kyphosis in Group A and Group B*

Changes	Group A ¹		Group B ²	
	Number	Per cent	Number	Per cent
Increase 10° or more	27	26.2	10	26.3
Decrease	1	1.0	1	2.6
No change	68	66.0	22	57.8
Patients dead or not traced	7	6.8	5	13.3
Total number of lesions	103	100.0	38	100.0

¹ See Table 16.² See page 82.

The difference in working capacity between group A and group B is significant both in children and in adults (see above) when related to complete working capacity only. If patients with partial working capacity are included, the difference is reduced in the case of children (see Table 47) to 11.9 per cent. This is insignificant (being slightly more than the standard error of difference, ± 7.8 per cent). The difference remains significant in the case of adults at 58.3 per cent (more than three times the standard error for this difference, ± 12.6 per cent).

The number of patients who failed to complete treatment according to plan was slightly greater in group B than in group A: eight patients had to be excluded from group B (see page 73), while five disappeared after three to six months, i.e. a total of 13 patients out of the original 45. In group A, 18 patients out of 100 failed to complete the planned twelve months of post-operative medication (see page 46). It is important to note that patients in group A who failed to complete treatment did so because of the disappearance of symptoms; those in group B might have failed for the same reason in one case, but probably not in the other cases.

Group A and Other Groups of Patients

The 25 patients in group B who were operated on after twelve months' treatment with anti-tuberculosis drugs did not differ essentially in composition from the entire group. There were thus no essential differences as compared with group A either. The pre-operative medication with SM, the operations, and the post-operative anti-tuberculosis medication were the same in the two groups, the only difference in treatment being that the pre-operative medication with INH and PAS had lasted longer in group A.

At the follow-up examination the working capacity and the radiological findings were the same for the two groups, as shown by Tables 52 and 53 respectively. Slight complaints were found with the same frequency, while the post-operative recumbency, the hospitalization and the interval between operation and full resumption of work were all shorter for the group of 25 patients.

The remaining three groups of patients were too small to justify any comparison.

TABLE 52. *Working capacity in Group A and in 25 patients operated on after receiving ambulatory treatment with anti-tuberculosis drugs for twelve months*

Working capacity	Children				Adults			
	Group A ¹		25 patients ²		Group A ¹		25 patients ²	
	Num- ber	Per cent	Num- ber	Per cent	Num- ber	Per cent	Num- ber	Per cent
Complete	40	95.2	13	100.0	40	69.0	6	50.0
Partial	—	—	—	—	6	10.3	2	16.7
Incapacity, dead or not traced for examination	2	4.8	—	—	12	20.7	4	33.3
Total	42	100.0	13	100.0	58	100.0	12	100.0

¹ See Table 10.

² See page 87.

TABLE 53. *Radiological improvement in Group A and in 25 patients operated on after receiving ambulatory treatment with anti-tuberculosis drugs for twelve months*

Group A ¹		25 patients ²	
Number	Per cent	Number	Per cent
81	78.6	22	88.0

¹ See Table 13.

² See page 87.

Discussion

(a) *Justification of the treatment under investigation*

Practicability. It was found possible to carry out the proposed anti-tuberculosis medication according to plan, both with regard to types of drug and to doses, except in a few cases where there was intolerance to PAS and SM. The duration of pre-operative medication was planned to be left to chance, and was generally determined by the time that the patient had to wait before a bed became available in the ward. Post-operative medication did not always follow the plan; it was discontinued prematurely by 18 patients (18.0 per cent) because of the absence of symptoms, and prolonged in the case of 39 patients (39.0 per cent). In most of these cases, the doctor at the out-patient clinic gave new supplies of drugs simply out of habit.

Examination for PAS in the urine showed that nearly 90.0 per cent of the ambulatory patients were taking the prescribed PAS (see page 46). This is in accordance with the findings of WESSEL AAS (1960), at the same hospital and during the same period, in 201 tests on ambulatory patients suffering from pulmonary tuberculosis: 73.7 per cent positive, 7.4 per cent weak (i.e. PAS not taken for the last 24–48 hours) and 18.9 per cent negative. He classified as negative those patients who stated that their supply of PAS was exhausted, while eight such patients were classified as positive in the present investigation.

It was possible to carry out the operation according to plan, in respect of both time and technique, except in a few cases where temporary postponement was necessary owing to intercurrent attacks of malaria, colds, measles, etc. It was not possible to determine the extent to which an elimination of the lesion was achieved, but 11 patients required re-operation.

Enforced recumbency was omitted as planned, and patients got up as much and as early as they wished, even only one to two days after operation. Immobilization was also omitted.

Hospitalization was reduced to an average of thirty-five days, in accordance with the period of four to six weeks planned; it was within the planned period in over 70.0 per cent of cases, in spite of additional operations for extraspinal tuberculosis of bones and joints, treatment for pulmonary tuberculosis, etc.

Comparison of results of treatment with those published in earlier reports. Working capacity, frequency of slight complaints, recovery from paraplegia, radiological findings and operative mortality were all found to compare favourably with the findings published in earlier reports (see page 100), but caution is necessary in prognosticating the long-term results of treatment. Clinical kyphosis and increase in radiological kyphosis were similar to the findings in earlier studies, but it should be recalled that (i) the kyphosis may later increase in growing children, and (ii) the kyphosis was very seldom discussed in earlier reports in relation to the age of the patients or the region of the spine involved. However, it appears that the important factors in regard to kyphosis are: the age of the patient, the region of the spine involved and the extent of the lesion (see page 70). On the other hand, it appears to be of no importance from the point of view of kyphosis whether the diseased material is eliminated by surgery or by the human organism's own forces, nor does early ambulation appear to have any effect.

The time-factor was markedly reduced in the present investigation, including the duration of recumbency, the hospitalization and the interval between the operation and full resumption of work. One reason may be that the operation removes the diseased material in the lesion which, without operation, the organism must resorb, encapsulate or discharge through a sinus: all these processes take time. An additional reason may be that patients were not exposed to the adverse side-effects of recumbency or immobilization for as long as in other forms of treatment.

(b) Effect of various factors on prognosis

Operation. The working capacity was better, the radiological improvement and fusion were found more frequently in group A than in group B (see pages 107–108), and there was an over-all saving of time. The reason for this was most probably the operation, with its removal of diseased material, but an effect of the hospitalization and the addition of SM cannot be excluded.

Age was the main factor besides operation which affected the prognosis (see page 63): children had complete working capacity more often

than adults; they had slight complaints less frequently, and the interval between operation and full resumption of work was shorter than among adults. No difference in working capacity could be found by any further breakdown into age groups (see Table 17). This indicates that the growing spine has a better capacity for recovery than the fully grown; thereafter an age difference had no effect on this capacity within the limits of the age groups investigated, namely 11½ to 58 years. This theory is supported by the fact that, in group B also, children had better working capacity than adults.

On the other hand, there was no effect of age on the more objective signs of healing: recovery from paraplegia, healing of sinus, occurrence of complications during treatment, and radiological improvement (see page 63). Thus the effect on the prognosis may be more apparent than real, and merely illustrate the difference in the character of 'work' for children and adults: in children, short periods of intense exertion normally alternate with periods of rest, while in adults, exertion is usually continuous over long periods.

While age had no effect on the frequency of radiological improvement, it did affect the type of improvement: adults improved more frequently by fusion (see page 63); it may be deduced that children improved more by normalization of structure, sharpening of contours and filling-in of defects. This difference was seen in both upper and lower spinal lesions.

Duration of symptoms and radiological grouping. It may, at first sight, seem remarkable that these factors affect the results to such a small degree. One reason may be that the number of patients with a history of less than six months, or with a lesion in radiological group 1, was too small for any possible difference in prognosis to be brought out. A further reason may be that, once the diseased material is removed by surgery, it is the completeness of the removal which is important, and not the time for which this material has been present, or its amount.

The fact that *pulmonary and extrapulmonary complications* had no harmful effect on the prognosis for working capacity has also been reported by FELLÄNDER (1954), using drugs and radical operation; on the other hand, ALVIK (1949) found, with orthodox treatment, that the prognosis was worse when they were present. This difference may be due to the effect of the anti-tuberculosis drugs, or to the operative removal of the diseased material, which subjects the organism to less strain than in the case of resorption and encapsulation, etc.

Anti-tuberculosis medication. No effect was demonstrated of previous medication, but the number of patients may possibly have been

too small for such an effect to be brought out. The fact that apparently inadequate previous medication produced no harmful effects may be connected with the seeming rareness of the development of resistance by the tubercle bacilli to anti-tuberculosis drugs in cases of tuberculosis of the spine. As mentioned on page 29, it was possible to carry out tests at the hospital for the detection of drug resistance only from the spring of 1960 onwards, at which time the whole of group A had been operated on. When tests were made for one of the 25 patients from group B who were operated on after twelve months, and for five of the eight patients operated on without any pre-operative anti-tuberculosis medication, resistance to INH, PAS, and SM combined was not found in any of these six cases. Examination of the next group of patients treated by the same methods as those used for group A showed resistance to all three drugs in one case out of 25 (KALBAK 1961). There is no reason to believe that any difference in resistance would have been found in group A.

The rareness of drug resistance in patients with tuberculosis of the spine has also been reported by other authors (see page 20). It is in contrast to the findings in patients with pulmonary tuberculosis; WESSEL AAS (1961), at the same hospital and during the same period, found that about one-fifth of such patients were resistant or moderately resistant to all three drugs.

The effect of the duration of pre-operative medication could be studied in three groups of patients: (i) the eight patients who were operated on without any pre-operative anti-tuberculosis medication; (ii) group A, where pre-operative medication was given for less than six months in 88.0 per cent of the patients; (iii) the 25 patients from group B who were operated on after a medication period of at least twelve months. Comparison of the findings shows that an increase in the pre-operative medication period is accompanied by a reduction in the number with gross pathological changes at operation, and the finding of acid-fast bacilli by microbiological examination and of tuberculous granulation tissue by histological examination (Table 54).

Working capacity and radiological findings were the same, whether the pre-operative medication period was less than one month, one to six months, or twelve months and more (Table 55). The biggest difference in the Table is the difference in radiological improvement, as between less than one month's medication (74.2 per cent) and twelve months and more (88.0 per cent); this difference is 13.8 per cent, but is still insignificant (being slightly more than the standard error of difference, ± 10.7 per cent). Post-operative recumbency, hospitalization, and the interval between operation and full resumption

TABLE 54. *Gross pathological changes at operation, acid-fast bacilli present on microbiological examination and tuberculous granulation tissue found by histological examination in material removed by operation (i) in 8 patients operated on without anti-tuberculosis drugs, (ii) in Group A with relatively short pre-operative medication and (iii) in 25 patients operated on after receiving ambulatory treatment with anti-tuberculosis drugs for twelve months*

Condition	8 patients ¹	Group A ²	25 patients ³
Gross pathological changes	8 out of 8	99 out of 100	14 out of 25
Acid-fast bacilli present	6 out of 8	53 out of 93 ⁴	1 out of 23 ⁴
Tuberculous granulation tissue present	7 out of 8	74 out of 98 ⁴	13 out of 25

¹ See page 88.

² See page 48 and Table 9.

³ See pages 85-86.

⁴ Examination not carried out in remaining cases.

TABLE 55. *Duration of pre-operative medication with anti-tuberculosis drugs, complete working capacity and radiological improvement*

Findings	Group A ¹				25 patients from Group B ²	
	Less than 1 month		1-6 months		12 months or more	
	Number	Per cent	Number	Per cent	Number	Per cent
Complete working capacity	22	73.3	47	81.0	19	76.0
Radiological improvement	23	74.2	46	78.0	22	88.0

¹ See Tables 25 and 26.

² See page 87.

of work were all shorter with a pre-operative medication period of twelve months and more (see pages 86-87), but total recumbency and total time for resumption of work were shorter for group A.

(There was a marked difference between the results of treatment for four patients in group A with a total medication period limited to two to four months, all of whom recovered complete working capacity, and six of the patients who were operated on without pre-operative anti-tuberculosis medication, although they were subsequently given INH and PAS for thirteen to sixteen months before the last follow-up examination. The number of patients in these two categories is too small for any conclusions to be reached, but the consistency of the findings is indicative. A possible explanation is that the timing of the

anti-tuberculosis medication in relation to the operation, and/or the addition of SM, are of greater importance than the duration of medication as such.)

(c) Choice of operation for children

Complete and partial working capacity were found in 40 out of 42 children in group A, and in 15 out of 18 children in group B. It was pointed out (see page 110) that this difference is insignificant. It may therefore be asked whether any advantage is gained by performing the operation on children. The following considerations favour operation:

(i) Complete working capacity was found significantly more often among children in group A than among children in group B (see page 107); (ii) complete working capacity with no clinical symptoms and signs, except possibly kyphosis, was found in 76.1 per cent of children in group A (see Table 10) and in 33.3 per cent in children in group B (see Table 31.) The difference, 42.8 per cent, is significant (being more than three times the standard error of difference, ± 13.6 per cent); (iii) radiological improvement was found in 73.8 per cent of children in group A (see Table 13) and in 26.3 per cent of children in group B (see Table 33). The difference, 47.5 per cent, is significant (being more than three times the standard error of difference, which is ± 13.6 per cent in this case also); (iv) when 13 children were operated on after twelve months' medication with anti-tuberculosis drugs, acid-fast bacilli were still found in the material removed in one case of the 12 children where this examination was done (see page 86), and tuberculous granulation tissue was found in four cases; there were no clinical or radiological findings which distinguished these children from those where acid-fast bacilli and tuberculous granulation tissue were not found.

The considerations against operation are (i) the insignificant difference in ensuing complete and partial working capacity among the children in group A and group B; (ii) no acid-fast bacilli were cultured in 11 of the 12 children operated on and examined for tubercle bacilli, and tuberculous granulation tissue was not found in nine of the 13 children. Indeed, in five of the 13 children operated on after twelve months' medication, there were no gross pathological changes on operation — apart from small amounts of granulation tissue in one case — nor could acid-fast bacilli be cultured, and histological examination showed only bone tissue, cartilage and fibrous tissue. (iii) It will be recalled that, in group B, the anti-tuberculosis medication lasted only twelve months; it was carried out under

ambulatory conditions and was restricted to INH and PAS. Better results might perhaps have been obtained if the treatment had lasted for a longer period, if the children had been hospitalized, and if SM had been administered in addition to INH and PAS.

There are thus important considerations for and against operation in children, and the matter cannot be decided on the basis of the present investigation.

Conclusions

1. The treatment for tuberculosis of the spine with anti-tuberculosis drugs in conjunction with radical operation, without enforced recumbency and immobilization, and with hospitalization for as short a period as four to six weeks in a general hospital, proved practicable except in very few cases. The two to two-and-a-half years results of this treatment compared favourably with those obtained with the usual treatment methods, as published in earlier reports by other investigators. Nothing can be said about long-term results. The time factor was reduced.
2. The results of this treatment probably depended on the combined effect of the anti-tuberculosis drugs (INH, PAS, SM) and the operation; they were less satisfactory following treatment with the drugs alone; a few observations indicated that they were also less satisfactory with operation alone.
3. Age affected the prognosis; children attained better working capacity than adults following treatment; slight complaints were less frequent among children, the recumbency was shorter, and there was also a shorter interval between operation and full resumption of work than in the adults. This effect of age may only be apparent and illustrate differences in the character of 'work' in children and adults, and in information on subjective complaints.
4. Age had no effect on the frequency of recovery from paraplegia, healing of sinus and occurrence of complications during treatment; however, this conclusion is based on small groups of patients.
5. Age affected the type but not the frequency of radiological improvement following treatment; children improved more often by normalization of structure, sharpening of contours and filling-in of defects; adults improved more by fusion.
6. Prolongation of pre-operative medication with anti-tuberculosis drugs from less than one month to twelve months and more, reduced

the number of cases found on operation to have gross pathological changes; there were also fewer patients with acid-fast bacilli found by microbiological examination and fewer with tuberculous granulation tissue observed by histological examination in the material removed by operation.

7. Prolongation of pre-operative medication with anti-tuberculosis drugs from less than one month to one to six months, or to twelve months and more, appeared to have no effect on the results of treatment (a few observations indicated that it was important that the medication should be started before the operation was performed). No conclusions could be reached on the optimal duration of the post-operative medication.

8. Prolonged observation from twelve months to two-and-a-half years, the duration of symptoms before operation, the region of the spine involved, radiological grouping (i.e. the extent of the lesion) and the presence or absence of pulmonary and extrapulmonary complications had no effect, or no significant effect, on working capacity and radiological improvement.

9. Age, the region of the spine involved and the extent of the lesion, affected the clinical kyphosis and the increase in radiological kyphosis; early ambulation had no effect on it.

10. Radical operation appeared to be indicated in all cases with florid tuberculosis of the spine in the age-range 17 months to 58 years; nothing can be said about older patients as they were not represented in the patient material investigated. Patients who are in a hopeless condition because of other diseases may be exceptions.

11. Children possibly may also be exceptions to this last statement, since ensuing working capacity in children appeared to be approximately the same using ambulatory treatment with INH and PAS, without operation. Should circumstances not permit hospitalization and operation of all patients, adults should therefore have priority.

12. Pulmonary tuberculosis is no contra-indication for operation, and the condition usually improved during the period of observation.

Summary

An investigation was planned to study whether enforced recumbency, immobilization and hospitalization for more than four to six weeks in specialized hospitals for bone and joint tuberculosis could be omitted in the treatment for tuberculosis of the spine by anti-tuberculosis drugs in conjunction with radical operation. The plan involved the treatment of a group of patients, group A, in the manner suggested, and their follow-up by regular clinical and radiological control examinations every two to three months over a period of two to two-and-a-half years, the findings to be compared with the results obtained by usual forms of treatment for tuberculosis of the spine. The studies took place at the 'National Medical Center in Korea', Seoul, South Korea. Findings published in reports by previous investigators were to be used for comparison, since time and bed capacity made it impossible to apply previous methods of treatment to any control groups of patients at the same time.

Should the findings in the planned investigation be in the affirmative, it was envisaged also to study the effect on prognosis of various factors. To study the actual effect of the anti-tuberculosis drugs alone, it was planned to treat another group of patients, group B, in the same way as group A, but without operation. The limited time available for the investigation made it necessary to confine the treatment of this group to twelve months before the follow-up examinations.

Group A consisted of 100 patients, with ages ranging from 17 months to 58 years. They were treated with isoniazid and para-aminosalicylic acid throughout the treatment period, with the addition of streptomycin during hospitalization. They were admitted for operation as soon as the bed capacity of the hospital permitted it, and the operation was carried out as soon as the necessary examinations had been completed. In practice 30.0 per cent of the patients were thus operated on within one month after medication with anti-tuberculosis

drugs was commenced and 54.0 per cent within two months. Hospitalization lasted thirty-five days on the average; more than 70.0 per cent of the patients were hospitalized forty days or less.

Patients were allowed to get up as soon and as much as they wanted, even on the day after the operation. Thus 10.0 per cent of the patients were completely up and about within one month of the operation, and 43.0 per cent within three months. Patients were not immobilized, and had active exercises.

The aim of the operation was to remove diseased material as completely as possible. Bone grafts, posterior fusion operation and post-operative local instillation of anti-tuberculosis drugs were not used.

The follow-up examination after two to two-and-a-half years included 94 of the original 100 patients in the group. Two patients could not be located and four had died. Complete working capacity was found in 80.0 per cent of the patients (40 children, 40 adults). The patients originally had 103 lesions (three patients had double lesions); radiological improvement was found in 78.6 per cent of the original number of lesions, or 89.0 per cent of 91 lesions examined at the last follow-up and where interpretation of the radiographs was possible. Recovery from paraplegia was observed in 16 out of 21 cases, even where this condition had lasted for as long as five years. The interval between operation and full resumption of work was less than three months in 45.0 per cent and less than twelve months in 74.0 per cent of the cases.

Complications were of minor importance except in two cases of surgical damage to the cord; both the latter patients were paraplegic before operation and one of them died after five months. The operative mortality may therefore be said to be 1.0 per cent. Re-operations were necessary in 11 cases.

The operation had a definite effect on prognosis; better results were obtained with anti-tuberculosis drugs in conjunction with operation than with anti-tuberculosis drugs alone, according to the findings in group B. This group was originally intended to include 45 patients, but eight had to be excluded for various reasons. Thus 37 patients, ranging from two to 58 years of age, underwent ambulatory treatment with isoniazid and para-aminosalicylic acid for twelve months, without enforced recumbency or immobilization. After twelve months, 32 patients with originally 33 lesions were followed up, while three could not be traced and two had died. Complete working capacity was observed in 35.1 per cent of the patients and radiological improvement in 28.9 per cent of the lesions. The interval between the time when treatment was started by the hospital and full resump-

tion of work was in no case less than three months, but two patients (5.4 per cent) were already able to work before treatment was started.

Age affected some of the clinical findings in group A: final working capacity was better in children than in adults, the frequency of slight complaints was lower in children, and the interval between operation and full resumption of work was shorter in children than in adults. This may be due mainly to the different character of 'work' as between children and adults, and differences in complaining, since no effect of age was observed on the more objective findings: recovery from paraplegia, healing of sinus and occurrence of complications during treatment. Neither was any effect on the frequency of radiological improvement observed. But the type of improvement was affected, since children improved more often by normalization of bone structure, sharpening of contours and filling in of defects, while adults improved more by fusion.

Age had the same effect on working capacity in group B as in group A.

Prolongation of observation time from twelve months up to two-and-a-half years, the duration of symptoms, the region of the spine involved, the extent of the lesion, and the presence of pulmonary and extrapulmonary complications, had insignificant effect or no effect at all on working capacity and radiological improvement. The results were not affected by the increase of pre-operative medication with anti-tuberculosis drugs ranging from less than one month to twelve months and longer. Twenty-five patients in group B were operated on after such a period. Gross pathological changes were found less frequently than in group A, where the duration of the pre-operative medication with anti-tuberculosis drugs was shorter. The number of patients with acid-fast bacilli and tuberculous granulation tissue in material removed by operation was smaller than in group A. Hospitalization was shorter than in group A, with an average of twenty-three days. The follow-up examination one-and-a-half years after the operation included 24 patients; one had died. Complete working capacity was found in 60.0 per cent of the patients and radiological improvement in 88.0 per cent, i.e. approximately the same findings as in group A.

Clinical kyphosis and increase in radiological kyphosis was affected by the age of the patient, by the region of the spine involved and by the extent of the lesion. Early ambulation had no such effect.

The conditions are discussed, permitting a comparison between the results of the treatment method used for group A and methods published by previous investigators. These conditions are also dis-

cussed as between group A and group B in the present investigation, and it is concluded that such comparisons are justified. They show that the two to two-and-a-half years results observed in this investigation compare favourably with the results obtained by the usual methods of treatment. Furthermore, the results obtained in group A were better than those obtained in group B.

It is concluded that the treatment under investigation is practicable and is justified. Operation appears indicated in all patients with florid disease, with the exception of those in a hopeless condition due to other diseases. Information is provided in this investigation regarding patients in the age range 17 months to 58 years only, however. If circumstances do not permit hospitalization and operation of all patients, adults should be given priority. Children could be treated without hospitalization and operation and attain approximately the same working capacity.

Pulmonary tuberculosis is no contra-indication for operation.

Résumé

Une enquête a été faite sur les possibilités de renoncer, dans le traitement mixte du mal de Pott par abord direct et administration de tuberculostatiques, à des mesures telles que le repos obligatoire, l'immobilisation, et une hospitalisation supérieure à quatre à six semaines dans un hôpital spécialisé en tuberculose ostéo-articulaire. On envisageait de traiter un groupe de malades (groupe A) suivant les modalités indiquées et de les soumettre à une surveillance clinique et radiologique par des examens répétés tous les deux ou trois mois pendant une période de deux ans à deux ans et demi, en comparant les résultats à ceux des traitements habituels du mal de Pott. L'étude a eu lieu à «The National Medical Center» à Séoul, Corée du Sud. Pour les résultats témoins, l'auteur se proposait de les rechercher dans la littérature, ne disposant ni du temps ni du nombre de lits adéquat pour appliquer parallèlement aux groupes témoins les traitements plus anciens.

Au cas où l'enquête donnerait des résultats positifs, on se proposait également d'étudier l'influence de divers facteurs sur le pronostic. Afin de préciser l'effet réel des seuls tuberculostatiques, on envisageait de traiter un autre groupe de malades (groupe B) de la même manière que le groupe A, à l'exclusion de la chirurgie. Faute de temps, ce deuxième groupe n'a pu être traité que douze mois avant les examens de contrôle.

Le groupe A comprenait 100 malades âgés de 17 mois à 58 ans. Leur traitement a comporté l'administration d'isoniazide et de PAS du début jusqu'à la fin, avec addition de streptomycine pendant l'hospitalisation. Leur admission en chirurgie a eu lieu dès que le permettait la capacité de l'hôpital, et l'intervention a été pratiquée aussitôt après les examens préopératoires habituels. Pratiquement, 30.0 pour cent des malades ont été ainsi opérés moins d'un mois après le début du traitement médical, et 54.0 pour cent dans les deux

mois. L'hospitalisation a duré 35 jours en moyenne; plus de 70.0 pour cent des malades ont été hospitalisés quarante jours ou moins.

Les opérés ont été autorisés à se lever très tôt et à volonté, parfois même dès le lendemain de l'intervention. Ainsi 10.0 pour cent des malades ont été complètement sur pied moins d'un mois après l'intervention, et 43.0 pour cent moins de trois mois après. Les malades n'ont pas été immobilisés, et ils ont pratiqué des exercices physiques.

L'intervention se proposait « l'exérèse totale » des tissus pathologiques. Il n'a été pratiqué ni greffe osseuse, ni arthrodèse postérieure, ni instillation post-opératoire *in situ* de tuberculostatiques.

Sur les 100 malades du groupe A, 94 ont subi un examen de contrôle au bout de deux ans à deux ans et demi. Deux n'ont pu être retrouvés et quatre étaient décédés. Quatre-vingt pour cent (40 enfants, 40 adultes) jouissaient d'une capacité de travail intégrale. A l'origine, 103 lésions avaient été dénombrées chez ces malades (trois malades avaient des lésions doubles); 78.6 pour cent de ces lésions ont été améliorées du point de vue radiologique. Ceci correspond à 89.0 pour cent pour les 91 lésions soumises au dernier examen de contrôle ou l'interprétation des clichés a été possible. La guérison de la paraplégie a été constatée dans 16 cas sur 21, même lorsqu'elle existait depuis cinq ans. L'intervalle entre l'intervention et la reprise complète du travail a été inférieur à trois mois dans 45.0 pour cent des cas, et inférieur à douze mois dans 74.0 pour cent.

Les complications ont été mineures, sauf deux cas de lésions chirurgicales de la moelle; il s'agissait dans les deux cas de malades déjà paraplégiques; l'un des deux était mort cinq mois plus tard. On peut donc chiffrer la mortalité opératoire à 1.0 pour cent. Une réintervention a été nécessaire dans 11 cas.

L'intervention a exercé une certaine influence sur le pronostic. L'observation des malades du groupe B a démontré que le traitement mixte médocochirurgical donnait de meilleurs résultats que la seule administration de tuberculostatiques. A l'origine, ce groupe devait comprendre 45 malades, mais 8 ont dû en être exclus pour différentes raisons. Ainsi 37 malades âgés de 2 à 58 ans ont été traités par l'isoniazide et le PAS sans repos obligatoire ni immobilisation. Après 12 mois, 32 malades originellement porteurs de 33 lésions ont été réexaminés; trois n'ont pu être retrouvés et deux étaient décédés. Trente-cinq virgule un pour cent des malades avaient une capacité de travail complète, et 28.9 pour cent des lésions étaient améliorées. L'intervalle entre le début du traitement à l'hôpital et la reprise totale du travail n'a jamais été inférieur à trois mois; mais deux malades (5.4 pour cent) étaient aptes au travail avant tout début de traitement.

Dans le groupe A, l'âge a pu, parfois, jouer un certain rôle: capacité de travail meilleure chez les enfants que chez les adultes, moindre fréquence de petits troubles chez les enfants, intervalle plus court, chez ces derniers, entre l'intervention et la reprise d'une activité complète. Cela peut être dû surtout à la différence entre le «travail» de l'enfant et celui de l'adulte et à une différence des complaints, car il n'a été constaté aucune influence de l'âge sur les signes objectifs tels que la guérison d'une paraplégie, le tarissement d'une fistule et la survenue de complications pendant le traitement, pas plus que sur la fréquence des améliorations radiologiques. Mais les modalités de ces améliorations en ont été affectées, consistant surtout en une normalisation de la structure osseuse, une accentuation des contours et un remplissage des cavités chez l'enfant, et plutôt en fusions osseuses chez l'adulte.

L'influence de l'âge sur la capacité de travail a été la même dans les deux groupes A et B.

La prolongation de la période d'observation de douze mois à deux ans et demi, la durée des symptômes, la localisation des lésions et leur étendue, ainsi que la présence de complications pulmonaires et extra-pulmonaires n'ont exercé sur la capacité de travail et sur les améliorations radiologiques que des effets insignifiants. La durée du traitement médical pré-opératoire par les tuberculostatiques, allant de un à douze mois et davantage, a également été indifférente.

Vingt-cinq des malades du groupe B ont été opérés après douze mois. Des altérations pathologiques manifestes ont été moins souvent constatées à l'intervention que dans le groupe A, dont le traitement pré-opératoire par les tuberculostatiques avait été plus court. Moins nombreux aussi, par rapport au groupe A, les malades ayant des bacilles acido-résistants et du tissu de granulation tuberculeuse dans le matériel prélevé à l'intervention. La durée de l'hospitalisation a été moindre dans le groupe B que dans le groupe A, avec une moyenne de 23 jours pour le premier. Vingt-quatre malades ont été examinés un an et demi après l'opération; un malade était mort. Soixante pour cent des malades avaient récupéré leur entière capacité de travail, et 88.0 pour cent avaient été améliorés du point de vue radiologique, constatations presque identiques à celles du groupe A.

Le degré de cyphose clinique et son accentuation radiologique ont été influencés par l'âge du malade, par la localisation des lésions et par leur étendue; le lever précoce n'a eu aucun effet.

Les conditions ont été discutées qui permettent de comparer les résultats du traitement appliqué aux malades du groupe A à ceux d'autres méthodes déjà publiées. La même discussion a également

porté sur la comparaison entre les groupes A et B, et il a été conclu à la validité de ces comparaisons. Celles-ci ont montré que les résultats après deux ans à deux ans et demi de cette enquête sont comparables à ceux des méthodes habituelles de traitement. En outre, les résultats du groupe A ont été meilleurs que ceux du groupe B.

En conclusion, le traitement étudié est à la fois praticable et justifié. L'intervention apparaît justifié chez tous les malades atteints d'une forme floride du mal de Pott, à l'exception de ceux dont l'état est désespéré par suite d'autres maladies. Toutefois la présente enquête a porté seulement sur des sujets âgés de 17 mois à 58 ans. Si les circonstances ne permettent pas d'hospitaliser et d'opérer tous les malades, les adultes devraient être admis avec priorité. Les enfants peuvent être traités sans hospitalisation ni intervention pour une récupération presque identique de leur capacité de travail.

La tuberculose pulmonaire ne constitue pas une contre-indication à l'intervention.

Zusammenfassung

Es wurden Untersuchungen unternommen, die zeigen sollten ob auf längeres Liegen, Immobilisierung und Spitalaufenthalt von mehr als 4 bis 6 Wochen in Spezialheilstätten für Knochen- und Gelenktuberkulose bei der Behandlung von Spondylitis tuberculosa durch Tuberculostatica und operative Herdausräumung verzichtet werden konnte. Die Studie betraf die Behandlung einer Gruppe von Patienten, Gruppe A, und deren 2-2½ jährige Überwachung durch regelmässige klinische und röntgenologische Untersuchungen alle 2-3 Monate. Die Resultate sollten mit denen der gewöhnlichen Behandlungen von Spondylitis tuberculosa verglichen werden. Die Studie wurde im „National Medical Center in Korea“, Seoul, Süd-Korea, unternommen. Als Vergleichsmaterial sollten Ergebnisse herangezogen werden, die in früheren Berichten von anderen Autoren veröffentlicht worden waren, da es Zeit- und Bettmangel unmöglich machten Kontrollgruppen von Patienten gleichzeitig auf klassische Art zu behandeln.

Fielen die Ergebnisse der Untersuchung positiv aus, so sollte auch der Einfluss auf die Prognose verschiedener Faktoren untersucht werden. Die Wirkung der Medikamente allein sollte bei einer anderen Gruppe von Patienten, der Gruppe B erforscht werden, deren Mitglieder ebenso behandelt wurden wie diejenigen der Gruppe A, aber nicht operiert wurden. Die Zeit war aber beschränkt und so dauerte die Behandlung der Patienten dieser Gruppe vor der Kontrolluntersuchung nur 12 Monate.

Gruppe A bestand aus 100 Patienten im Alter von 17 Monaten bis 58 Jahren. Sie erhielten während der ganzen Behandlungszeit Isoniazid und Paraaminosalicylsäure und ausserdem Streptomycin während ihrem Aufenthalt im Krankenhaus. Aufgenommen wurden sie sobald Betten frei waren und die Operation erfolgte sofort nachdem alle nötigen Untersuchungen ausgeführt worden waren. Praktisch wurden auf dieser Weise 30.0 % der Patienten in den ersten 4 Wochen

nach Beginn der medikamentösen Behandlung operiert und 54.0 % im Laufe der ersten 2 Monate. Die Dauer der stationären Behandlung war im Durchschnitt 35 Tage; über 70.0 % der Patienten blieben 40 Tage oder kürzer im Krankenhaus.

Die Patienten durften aufstehen sobald sie wollten, sogar schon an dem Tag nach der Operation. Auf diese Weise waren 10.0 % der Patienten nach einem Monat und 43.0 % nach 3 Monaten völlig auf den Beinen. Die Patienten wurden nicht immobilisiert und machten aktive Bewegungsübungen.

Ziel der Operation war die möglichst radikalste Ausräumung des kranken Gewebes. Knochentransplantation und postoperative Herdinstillation von Tuberculostatica wurden nicht gebraucht.

Die Kontrolluntersuchungen die nach 2–2½ Jahren durchgeführt wurden betrafen 94 von den anfänglich 100 Patienten der Gruppe. Zwei Patienten konnten nicht gefunden werden und 4 waren gestorben. Bei 80.0 % der Patienten (40 Kinder, 40 Erwachsene) war die Arbeitskapazität vollständig hergestellt. Diese Patienten hatten zu Beginn insgesamt 103 Läsionen (3 Patienten hatten Dobbelläsionen). Die Röntgenbilder wiesen eine Besserung in 78.6 % der Initialläsionen oder 89.0 % der bei der letzten Kontrolle untersuchten Läsionen auf – soweit eine Deutung möglich war. Heilung von Querschnittslähmung wurde in 16 von 21 Fällen beobachtet, sogar wenn dieser Zustand schon 5 Jahre andauert hatte. Die Zeitspanne zwischen der Operation und kompletter Arbeitsfähigkeit war kürzer als 3 Monate in 45.0 % und kürzer als 12 Monate in 74.0 % der Fälle.

Ausser in 2 Fällen von operativer Rückenmarksläsion waren die Komplikationen nicht ernsthaft; beide dieser Patienten litten vor der Operation an Querschnittslähmung und einer von ihnen starb nach 5 Monaten. Man kann also die operative Mortalität mit 1.0 % angeben. 11 Patienten mussten reoperiert werden.

Die Prognose wurde sicher durch die Operation beeinflusst; die Ergebnisse waren besser bei den Patienten die Tuberculostatica bekamen und operiert wurden, als bei denen die nur medikamentös behandelt wurden, wie man aus den Resultaten der Gruppe B sieht. Diese Gruppe sollte ursprünglich 45 Patienten umfassen, aber 8 mussten aus verschiedenen Gründen ausgeschieden werden. 37 Patienten im Alter von 2 bis 58 Jahren wurden also ambulatorisch mit Isoniazid und PAS behandelt, ohne Verschärfung der Bettruhe oder Immobilisierung. Nach 12 Monaten konnten 32 Patienten, die insgesamt 33 Läsionen hatten, einer Kontrolluntersuchung unterzogen werden, 3 konnten nicht gefunden werden und 2 waren gestorben. In 35.1 % der Fälle war die Arbeitsfähigkeit wieder vollständig hergestellt und

bei 28.9 % waren Besserungen des Röntgenbildes zu verzeichnen. Die Zeitspanne von Beginn der Behandlung im Krankenhaus bis zur vollständigen Wiederaufnahme der Arbeit betrug in keinem Falle weniger als 3 Monate, aber 2 Patienten (5.4 %) waren schon vor der Behandlung arbeitsfähig.

Das Alter hatte auf den klinischen Befund in Gruppe A einen gewissen Einfluss: bei Kindern war die Arbeitsfähigkeit grösser als bei Erwachsenen, auch beklagten sich Kinder weniger über leichte subjektive Symptomen und der Zeitraum zwischen Operation und Arbeitsbeginn war bei Kindern kürzer als bei Erwachsenen. Das kann aber hauptsächlich mit dem Unterschied der «Arbeit» von Kindern und Erwachsenen zusammenhängen und mit einem Unterschied in Klagen, denn objektiv waren folgende Faktoren nicht vom Alter beeinflusst: Heilen von Querschnittslähmung, Heilen von Fisteln und Auftreten von Komplikationen während der Behandlung. Auch die Anzahl der Besserungen im Röntgenbild waren dadurch nicht beeinflusst. Aber die Art der Besserung war verschieden, da es sich bei Kindern öfter um eine Normalisierung der Knochenstruktur, um eine Verschärfung der Umrisse und ein Ausfüllen der Läsionen, und bei Erwachsenen um Anchylose handelte.

Der Einfluss des Alters auf die Arbeitsfähigkeit war identisch in Gruppe B und Gruppe A.

Verlängerung der Beobachtungszeit von 12 Monaten auf $2\frac{1}{2}$ Jahre, Andauer der Symptome, Höhe der betroffenen Wirbel, Grösse der Läsionen und die Existenz pulmonarer und extrapulmonarer Komplikationen hatten sehr wenig oder gar keinen Einfluss auf die Arbeitsfähigkeit und auf die röntgenologische Besserung. Die Dauer der Behandlung vor der Operation (unter einem Monat bis 12 Monate und mehr) hat die Resultate nicht beeinflusst. Fünfundzwanzig Patienten der Gruppe B wurden nach 12 Monaten operiert. Makroskopisch-pathologische Veränderungen waren seltener als in Gruppe A, in welcher die Vorbehandlung durch Tuberculostatica kürzer gewesen war. Die Anzahl der Patienten bei denen die entfernten Gewebe säurefeste Bazillen und tuberkulöses Granulationsgewebe aufwiesen war geringer als in Gruppe A. Die stationäre Behandlung war kürzer als bei Gruppe A; Sie betrug im Durchschnitt 23 Tage. Die Kontrolluntersuchung $1\frac{1}{2}$ Jahre nach der Operation umfasste 24 Patienten; einer war gestorben. Vollständige Arbeitsfähigkeit wurde bei 60.0 % der Patienten festgestellt und röntgenologische Besserung bei 88.0 % d. h. die Ergebnisse waren denen der Gruppe A ungefähr gleichwertig.

Das Alter des Patienten, die Höhe des kranken Wirbels und die Grösse des Läsion beeinträchtigten die klinische Kyphose und die

Verstärkung der röntgenologischen Kyphose. Dasselbe kann von frühzeitigen Aufstehen nicht gesagt werden.

Es wird besprochen unter welchen Bedingungen die Resultate der Behandlungsmethoden von Gruppe A und jene die von anderen Autoren veröffentlicht wurden verglichen werden können. Die Besprechung betrifft auch die Bedingungen bei Gruppe A und Gruppe B unserer Studie; der Vergleich scheint gerechtfertigt. Er zeigt, dass die auf 2-2½ Jahren beobachteten Resultate dieser Studie sich vorteilhaft an jenen anderer Behandlungsmethoden messen können. Ausserdem waren die bei Gruppe A erzielten Resultate besser als jene bei Gruppe B.

Es wird daraus gefolgert, dass die hier besprochene Behandlung möglich und gerechtfertigt ist. Eine Operation ist bei allen Patienten mit florider tuberkulösen Spondylitis angezeigt, ausser ihr Zustand durch andere Gebrechen hoffnungslos sei. Unsere Studie gibt allerdings nur über Patienten im Alter von 17 Monaten bis 58 Jahren Auskunft. Wenn es nicht möglich ist alle Patienten im Krankenhaus aufzunehmen und zu operieren, sollte Erwachsenen Priorität zuerkannt werden. Bei Kindern kann etwa die selbe Arbeitsfähigkeit durch Behandlung ausserhalb des Spitals und ohne Operation erzielt werden.

Lungentuberkulose stellt keine Kontraindikation für die Operation dar.

References

Abbreviations used are according to the international code for the abbreviation of titles of periodicals in *World Medical Periodicals*, 3rd ed., World Medical Association (1961). In addition the following abbreviations have been used:

I. Europ. Symp. = I. Europäisches Symposium über die Behandlung der Skelett-Tuberkulose, 22.-23. September 1954. Reported in *Beilageheft zur Zeitschrift für Orthopädie*, (1956), Band 87.

II Europ. Symp. = II. Europäisches Symposium über die Behandlung der Skelett-Tuberkulose, 6.-7. Juni 1957. Reported in *Beilageheft zur Zeitschrift für Orthopädie*, (1959), Band 90.

Symp. Mal de Pott = Symposium sur le Mal de Pott, at the 36ème réunion annuelle de la Société Française d'Orthopédie, 8-10 novembre 1961. Reported in *Revue de chirurgie orthopédique* (1961) 47, 681-85.

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