T H E S I S
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submitted by

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T h e

SYMPTOMATOLOGY

a n d

DIAGNOSIS

o f

TUBERCULOUS SPINAL CARIES

i n

ADULTS.

P R E F A C E.

The observations recorded in this thesis are the result of investigations carried out at St. Luke's Hospital, Lowestoft.   This hospital, governed by the Metropolitan Asylum's Board, is for the treatment of adult cases of surgical tuberculosis, each patient being over 16 years of age.

The patients are drawn from all parts of the Metropolitan area, and the majority have been under some form of treatment at one or another of the London Hospitals, or Tuberculosis Dispensaries, before being sent to Lowestoft.

The Hospital contains 177 beds and of these about 40% are occupied by cases of spinal caries at any particular time.

On admission all patients are examined and their medical histories taken as a matter of routine.   In taking these histories, I have been struck by the frequency with which the spinal cases tell of months and even years during which they have been under treatment, before the diagnosis of Pott's disease was made.   I have therefore gone into the history of onset of spinal caries with more attention to details, and have questioned the patients closely as to their earliest symptoms, and the development of subsequent

signs and symptoms.

My endeavour has been to find out what
characteristic features, if any, are apparent in the
earlier symptoms of spinal caries, to aid in the
differential diagnosis.

In the following pages I purpose setting forth
the results of this investigation, and the deductions
I have drawn therefrom, and from observations made
while the patients have been under treatment at
Lowestoft.

INTRODUCTION.

The literature on the subject of Pott's disease in adults is, as far as I can ascertain, very limited. Spinal caries is usually dealt with from the point of view of its manifestation in children, the disease in the adult being accorded a passing reference.

That this should be so is, perhaps, not surprising when the greater frequency with which children are affected is considered. Pott's disease in the adult, however, is by no means a rare disease; it is a serious disease and it is an expensive disease. In all cases prolonged treatment is necessary, the patient being totally incapacitated from work, and when treatment is terminated a relative cure only can be assured, and the general resistance of the patient remains below normal. There can be no doubt that such a state of affairs is unsatisfactory and it is equally sure there is room for improvement.

The first and most important step to that end lies in measures for prevention of the disease, but these do not enter into the scope of this work.

The second factor in obtaining an improvement with regard to this disease is its early diagnosis.

Spinal caries, particularly in adults, is not easy to diagnose in its early stages, for various reasons; but it would appear to be agreed upon by those who have had long experience in the care of cases of Pott's disease that at the present day a correct diagnosis is made much earlier in children than was the case formerly. [i.]. That this improvement exists in connection with the disease in adults, is not stated.

The usual period between the onset of symptoms, and the making of a correct diagnosis is one to two years, and in most cases this period has been occupied by treatment for various ailments wide of the real trouble. Although the treatment of spinal caries dwells with the surgeon rather than the physician, yet the diagnosis is most often confused with non-surgical conditions such as lumbago and neuritis. Consequently the symptomatology and diagnosis of Pott's disease come to have particular significance from the medical point of view.

It is essential for early diagnosis in adults, to realise that the manifestation of tuberculous spinal caries is not the same for child and adult, and the two forms are dissimilar in the development of symptoms to the extent almost of constituting separate diseases.

The earlier the diagnosis is made, the sooner will treatment be instituted; the sooner treatment is

begun, the better will be the prognosis for the patient, and it will be attained more economically.

Before proceeding to a consideration of the symptoms of Pott's disease in the adult it seems advisable to make a brief reference to certain anatomical and physiological facts which have a bearing on the subject.

These are drawn mainly from Cunningham's Text book of Anatomy.

ANATOMY & PHYSIOLOGY.

The vertebral bodies consist of spongy bone, the spaces of which are lined by endosteum and filled with marrow. The circumferential layers of bone are condensed to form a more compact structure, which is most dense in the posterior vertical surface of the vertebral body.

The bone of the vertebral arch and processes has a greater proportion of compact bone than that of the body.

Ossification takes place in cartilage around the notochord.

At puberty certain secondary centres of ossification appear in connection with each vertebra, and two of these are for the formation of epiphyseal plates, one at each of the superior and inferior surfaces of the body. These secondary centres do not completely unite with the rest of the vertebra until about the 25th. year.

The intervertebral cartilages act as pads between adjacent vertebrae and are very firmly attached to the epiphyseal plates of the bodies.

The vertical surfaces of the bodies are slightly concave from above downwards except posteriorly where they are flat, forming the anterior wall of the spinal

canal.

<u>Ligaments</u>.   The ligaments of the spine are numerous.
On the anterior aspect is the anterior common ligament
which is a broad stratum of longitudinally placed fibres,
extending from the axis above to the first piece of the
sacrum below; it is firmly attached to the intervertebral
fibro-cartilages and loosely to the vertebral bodies.
The posterior common ligament extends upon the posterior
aspect of the vertebral bodies between the axis and the
sacrum, being within the vertebral canal; it is attached
to the adjacent margins of the vertebral bodies over
their entire width, the fibres passing over the
intervertebral cartilages and the main part of the bodies.
In the thoracic and lumbar regions the width of the
ligament is considerably reduced opposite the vertebral
bodies.

The vertebral laminae, the spinous processes, the
transverse processes and the articular processes are
joined together by ligaments arranged simply between
adjacent vertebrae.   The laminae are united by the
ligamenta flava which help to form the roof of the
spinal canal.

The interspinous ligaments are strongest in the
lumbar region where ventro-flexion is the most extensive
movement, and weakest in the thoracic region where this

movement is limited. In the cervical region the supraspinous ligaments are developed to such an extent, that they form a median elastic partition projecting posterior to the spinous processes and known as the ligamentum nuchae. The intertransverse ligaments are usually absent in the cervical and upper dorsal regions.

The intervertebral joints formed by the articular processes are provided with capsular ligaments, each having a synovial lining.

Movements. The articulations between the vertebrae, and the dispositions of the ligaments, are such that there is very little movement possible between any two adjacent vertebrae. When this, however, is taken in conjunction with the movement at all the intervertebral articulations, a considerable range of movement is rendered possible.

Movement of the spine is effected by muscular activity, and posture is maintained largely in the same way. The spinal ligaments help to keep the parts in apposition during movement, checking abnormal and excessive movement.

Flexion depends upon the compressibility and elasticity of the fibro-cartilages, and its range is greatest in the regions of the spine where these cartilages have the greatest depth, i.e. in the lumbar and cervical regions. Backward flexion is most pronounced in the

cervical region and forward flexion in the lumbar region.

Lateral and rotatory movements are possible in varying degrees in different regions of the spine according to the direction of the articular surfaces in these regions. Lateral flexion is permitted in the lumbar, but not in the cervical and dorsal regions. Rotation is possible in the thoracic, but not in the cervical and lumbar regions. In the cervical region, although they cannot take place as isolated movements, a combination of lateral flexion and rotation can produce a form of rotation in an oblique median axis.

The intervertebral foramina are bounded above and below by successive pedicles of the vertebral arches; in front by the bodies and fibro-cartilages, and behind by the ligamenta flava and the articular processes. They are placed thus, close to the articulations, in such a way that ordinary movement has practically no effect on the size of the foramina.

The vertebral canal varies in size and shape in different parts of the spine. In the cervical and lumbar regions it is large and triangular, while in the dorsal region it is narrow and circular. The size of the tube of dura mater enclosing the spinal cord varies in the same sense as the size of the canal.

The spinal dura mater is very loosely adherent to the cord and the nerve roots of the cauda equina. At the superior end it is firmly fixed to the 2nd. and 3rd. cervical vertebrae, and round the margin of the foramen magnum; below at the level of the 2nd. piece of the sacrum it narrows to form the greater part of the filum terminale externum which is fixed to the periosteum of the coccyx. In between, the dura is separated from the walls of the canal by an interval which is occupied by fat and a plexus of thin walled veins. The dura is loosely fixed anteriorly by fibrous connections with the anterior common ligament, and laterally by the nerve roots which, as they pierce the dura mater, carry with them tubular sheaths of dura into the intervertebral foramina. The dura and posterior wall of the canal are not connected in any way.

The vertebral column in the child presents a continuous antero-posterior convexity which persists in the thoracic region throughout life. After the age of 6 months a posterior lumbar concavity begins to develop; but is only marked to any extent in the standing position, and is usually obliterated in the sitting position, until puberty. A slight posterior cervical concavity develops also by the end of the first year of life.

In the adult these 3 physiological curves are normally well defined in the erect position, and merge

gradually one into the other. In addition there is a
posterior convexity formed by the sacrum, continuous
with the lumbar curve at the lumbo-sacral articulation,
which forms a marked forward prominence. The cervical,
thoracic and lumbar curves are all capable of
modification by the movements of the column. Of these
the thoracic curve is least subject to normal variations.

Blood Supply.   The arterial supply of the vertebral
bodies is derived from the spinal branches of the
vertebral, deep cervical, intercostal, lumbar and
lateral sacral arteries.   These spinal arteries enter
the vertebral canal by way of the intervertebral
foramina, and each divides into three branches :-
(1) to supply the posterior aspect of the canal:
(2) a neural branch, which divides into two branches
which follow the corresponding anterior and posterior
nerve roots, pierce the dura mater, and unite with the
anterior and posterior spinal arteries in supplying the
cord and its membranes; and (3) to form with the
corresponding branches of adjacent spinal arteries, a
chain of communicating vessels on the posterior aspect
of the vertebral bodies. It is from this chain that
the bodies derive their nutrient vessels.

The venous return from the cord is mainly by
radicular efferent vessels which follow the roots and
communicate with the epidural venous plexuses.   The

veins from the vertebral bodies also communicate with
these plexuses, which are drained mainly by the anterior
longitudinal vertebral veins, which lie between the
posterior common ligament and the vertebral bodies, and
communicate superiorly with the intra-cranial veins.
Another important efferent pathway for the venous return
is by way of the intervertebral veins, which pass with
the nerve trunks out of the intervertebral foramina to
join the veins corresponding to the arterial vessels of
supply.

<u>Nerve Supply</u>.   Presumably the periosteum is supplied
with nerve fibres from the nerves supplying the muscles
attached to the vertebrae.   R. J. Behan has shown
experimentally that the endosteum of bones in the dog
is sensitive to injury. [ii.]   It would appear possible
that the arteries entering the bone might convey nerve
fibres to the bone cells along with their own vasomotor
fibres.   Prof. A. Thomson states that 'the nerves which
accompany the arteries are probably destined for the
supply of the coats of these vessels.   Whether they end
in the bony tissue or not is unknown! [iii.]   Oppenheimer
is referred to by Behan as giving bone as an example of
a tissue which is free from pain, because when the
bloodvessels enter the compact structure of the bone
they discard their muscular coat, and so lose their
vasomotor nerves and the pain sense. [iv.]

Relations of the vertebral bodies.   The vertebral bodies
are covered anteriorly   (1)   by periosteum,

(2)   in part by the anterior
common ligament, and   (3)   by fascia continuous with
that covering adjacent muscles.   The arrangement of the
fascial covering varies in different regions.

In the neck the prevertebral fascia forms a well
defined layer in front of the vertebrae and the muscles
on the antero-lateral aspect of the bodies.   Superiorly
this fascia is attached to the base of the skull;
laterally it becomes intimately associated with the
posterior wall of the carotid sheath, and unites with
the fascia on the deep surface of the sterno-mastoid
muscle;   inferiorly the fascia passes into the superior
mediastinum of the thorax.

In the thorax the prevertebral fascia is not so
well defined as in the cervical and lumbar regions,
being in intimate contact with the periosteum and
anterior common ligament.   Laterally it is continuous
with the fascia covering the ligaments of the costo-
vertebral articulations.

In the abdomen the prevertebral fascia is derived
from the psoas fascia on either side, and it is more
easily defined than that of the thorax, with which it is
continuous by way of the aortic opening and beneath the
internal arcuate ligaments.   An additional fascial

covering is derived from the posterior layer of the
fascia of Zuckerkandl and Waldeyer.

The oesophagus and sympathetic cords in the neck;
the oesophagus, aorta and its branches, thoracic duct,
venae azygoi and the parietal pleura in the thorax;
the great vessels, their branches and the sympathetic
cords in the abdomen - all bear close relationship to
the anterior and lateral aspects of the vertebral bodies.

Certain muscles also are associated anteriorly. In
the neck the longus colli, and the rectus capitis anticus
major muscles lie on the antero-lateral surface of the
bodies, the former being attached to all the cervical
vertebrae except the 5th., and also to the first three
thoracic vertebrae.

The diaphragm is attached by its crura to the fronts
of the lumbar vertebrae and intervertebral discs, the
right crus extending as low as the disc between the third
and fourth lumbar bodies, and the left crus to the disc
between the second and third.

The psoas muscle arises by fleshy fibres from (1)
the lateral aspect of the intervertebral discs, and
adjacent borders of the bodies, from the lower border of
the 12th. thoracic to the upper border of the 5th.
lumbar vertebra; (2) four aponeurotic arches opposite
the first four lumbar vertebral bodies, and (3) the

transverse processes of all the lumbar vertebrae.   The
muscle fibres pass downwards in the posterior abdominal
wall and form a fusiform body which passes beneath
Poupart's ligament over the pubic ramus, and is inserted
by means of a tendon into the small trochanter of the
femur.   It is intimately associated with the iliacus
muscle from the level of the pelvic brim downwards, and
the two muscles are inserted together.   Below Poupart's
ligament the psoas lies behind the femoral artery and
also to its outer side.   The psoas muscle is covered
by a well marked layer of deep fascia - the psoas fascia -
which obtains firm attachment to the sites of origin of
the muscle, and also becomes continuous with the fascia
over the fronts of the vertebrae, at the points where
the muscle arises from the bodies and discs.   Laterally
the fascia becomes continuous with the posterior
aponeurosis of the transversalis abdominis muscle.

Although remote relations of the spine itself, two
intermuscular spaces in the back, on each side, are of
importance in relation to psoas abscesses.   These
spaces are Grynfeldt's space, and the triangle of Petit.
Grynfeldt's space is roughly quadrilateral, and is
bounded above and internally by the lower border of the
serratus posticus inferior muscle;   above and externally
by the last rib;   below and externally by the posterior
border of the internal oblique muscle;   and below and
internally by the outer border of the erector spinae

muscles, and the outer border of the quadratus lumborum
muscle.   The space is roofed over by the latissimus
dorsi muscle, and the floor is formed by the posterior
aponeurosis of the transversalis abdominis.   Deep to
the floor of the space three nerves pass in an outward
and downward direction, in close relation to the
aponeurosis, which they may pierce near the outer margin
of the space;   these nerves are, from above downwards,
the subcostal, the ilio-hypogastric and the ilio-inguinal.

The triangle of Petit is a subcutaneous space
bounded below by the crest of the ilium, internally by
the lower border of the latissimus dorsi, and externally
by the posterior border of the external oblique muscle.
The internal oblique forms a deep relation to the space.

The Spinal Cord.   This is the most important posterior
relation of the vertebral bodies, being separated from
the periosteum of the bones by its membranes, the fat
and areolar tissue of the epidural space, the posterior
common ligament and the vascular plexuses beneath.

The lower end of the cord is placed at the level of
the disc between the 1st. and 2nd. lumbar vertebrae.
Here it tapers sharply to form a conical extremity - the
conus medullaris.   The filum terminale is a fine thread-
like structure, which passes from the tip of the conus
to obtain attachment to the coccyx.   It is accompanied

by the nerve roots from the segments below the 1st.
lumbar, forming the cauda equina.

The segments of the cord, from which the spinal
nerves take origin, are placed at higher levels than
the corresponding vertebrae, so that the nerve roots
take a downward direction in passing from their origin
to the intervertebral foramina, this being most marked
in the lower regions of the spine and in the cauda equina
where the direction is pratically vertical.

The relations of the different spinal segments to
the vertebrae may be indicated by the following:-

   The 1st. cervical segment is opposite the atlas and
   odontoid process of the axis.

   the 8th. cervical segment is opposite the disc
        between the 6th. and 7th. cervical vertebrae.

   the 5th. thoracic segment is opposite the disc
        between the 3rd. and 4th. thoracic vertebrae.

   the 10th. thoracic segment is opposite the 8th.
        thoracic vertebra.

   the 1st. lumbar segment is opposite the disc
        between the 10th. and 11th. thoracic vertebrae.

   the 4th. and 5th. lumbar segments are opposite the
        12th. thoracic vertebra.

   the sacral segments are opposite the 1st. lumbar
        vertebra.

Throughout the greater part of its length the cord
presents a uniform girth, but in the cervical and lumbar
regions are marked enlargements.   The cervical enlargement
begins gradually at the upper end of the cord, attains its

greatest width about the 5th. and 6th. cervical segments
(disc between the 4th. and 5th. cervical vertebrae) and
subsides at the 2nd. thoracic segment.   The lumbar
enlargement extends from the 10th. thoracic segment;
is greatest at the 12th. thoracic segment (lower border
of the 10th. thoracic vertebra) and tapers rapidly to
the conus medullaris.

During full flexion of the spine the tip of the
conus rises slightly in the canal.

The anterior and posterior nerve roots are
separated from each other in the vertebral canal.   In
the subarachnoid and subdural spaces the ligamentum
denticulatum serves this purpose, and, after piercing
the dura, the anterior and posterior nerve roots are
enclosed in separate sheaths of that membrane.   These
sheaths remain distinct as far as the posterior root
ganglia, which are situated within the intervertebral
foramina;   thereafter the sheaths unite to form one
sheath for the combined nerve trunk.   Outside the
foramina the dural coats become continuous with the
fibrous sheaths of the nerves.

Immediately after leaving the intervertebral
foramen, each spinal nerve trunk divides into two - the
anterior and posterior primary divisions.   Each of these
contains fibres from both spinal roots.

The posterior primary divisions, with the exception
of those of the first two cervical nerves, are much
smaller than the anterior divisions.   They pass
backwards and immediately become associated with the
deep surface of the postvertebral muscles of the back.

The anterior primary divisions receive the grey
rami communicantes of the sympathetic system, and then
pass to their distribution.   In the thoracic region
the nerves are mostly distributed simply and segmentally.
Elsewhere distribution is complicated by the formation
of nerve plexuses (1) Cervical (2) Brachial (3)
Lumbo-sacral.

The cervical plexus lies close to the lateral
aspect of the vertebral bodies under cover of the sterno-
mastoid muscle with the rectus capitis anticus major in
front and the scalenus medius behind.

The brachial plexus lies between the scaleni, anticus
and medius.

The thoracic nerves pass outwards between the parietal
pleura anteriorly and the posterior intercostal aponeuroses
posteriorly, to pierce the latter opposite the angles of
the ribs.

The lumbar plexus is formed in the substance of the
psoas muscle.   The sacral portion of the lumbo sacral

plexus lies between the parietal pelvic fascia anteriorly and the pyriformis muscle behind.

Gangiated Cord of the Sympathetic.   The sympathetic chains lie one on each side of the vertebral bodies, separated from the vertebra, in the neck, by the prevertebral muscles; in the thorax, they are placed more laterally in front of the necks of the ribs, and the intercostal vessels and nerves; in the lumbar region, they are more closely related to the front of the vertebral bodies, internal to the psoas attachments but anterior to the lumbar vessels.

ETIOLOGY.

In all cases tuberculous spinal caries is the result
of the activity of the Bacillus Tuberculosis.   Either
the human or the bovine type may be the exciting factor
in any individual case, but in adults, the number of
cases infected by the bovine type of the Bacillus
Tuberculosis is very small compared with those infected
by the human type.

Sir Henry Gauvain has analysed 62 cases of spinal
caries in children, the pus in each case having been
examined by Stanley Griffith with regard to the type of
bacillus infecting.   The results, arranged according to
the ages of the patients, are the following.   v.

Age.	Human type.	Bovine type.
Under 5 years	7	12
5 - 10 "	11	18
10 - 15 "	10	4

Griffith has investigated this point in bone and
joint tuberculosis regardless of the region affected, and
his results are as follows:-   vi.

Age.	Human type.	Bovine type.
Under 5 years	57	25
5 - 10 "	121	42
10 - 16 "	77	8
Over 16 "	48	3

It is clear that in adults the incidence of
infections by the bovine type is very small.

Sex.   This has no apparent effect on the incidence of spinal caries.

Heredity, Environment, Occupation..   In the series of 70 cases which I have investigated there has been no evidence of any special hereditary, environmental or occupational influence upon the infection.   It is true that the majority of the patients have come from homes in congested areas of London, many from one and two roomed homes; but the health visitors' reports on these homes have been in most cases favourable as to sanitary conditions and fresh air.

With regard to the occupational environment, it has been impossible to obtain any reliable information from the hygienic standpoint.

Although occupation does not appear to show any relationship to the incidence of the disease, yet a general connection may be drawn between the mode of onset and occupation.   Those patients, whose occupations involve much sedentary work, usually give a history of receiving treatment over long periods for backache, while those engaged in heavy muscular work provide the cases which proceed to abscess formation, or deformity, without pain, or else with a comparatively short period of preliminary pain.

Local Predisposition.   The incidence of spinal

tuberculosis; relative to other forms of bone and joint
tuberculosis, appears to vary widely in the experience of
different recorders.   The figures given by C. C. Choyce,
to indicate the local predisposition at all ages, are   vii

Spine 23%, Knee 16.5%, Hip 14.6%, Tarsus 14.4%.

G. Potel, however, holds spinal infections as being not
quite so frequent as hip disease, and puts the percentage
of cases of non-pulmonary tuberculosis due to spinal
caries at about 16%.   viii.

From the statistical point of view, the figures
given by an analysis of the cases admitted to St. Luke's
Hospital cannot be considered as accurately representing
the relative frequency with which the different regions
of the body are affected by tuberculosis;   because,
before being sent there, the patients have been under
the care of some general hospital or tuberculosis
dispensary, where selection has been made of those
considered suitable for treatment in that hospital.
It is, however, interesting to observe that these
figures correspond fairly closely with those given by
R. Whitman, who records that out of a total of 10,850
cases of bone and joint tuberculosis of all ages,
treated at the Out Patient Department of the Hospital
for Ruptured and Crippled, in New York, 4,299 or 39.6%
were cases of Spinal Caries.   ix.

Out of 368 cases of bone and joint tuberculosis
admitted to St. Luke's Hospital during the years 1924 and
1925, 138 or 37.5% were suffering from spinal caries.
Compared with Potel's estimation of 16% of cases of non-
pulmonary tuberculosis, the figure for St. Luke's
Hospital during 1924-25 was 27.6%.

A comparison of all bone and joint cases treated in
the hospital during the same period gives the following
figures:-

Spine 37.5%, Hip 30.7%, Knee 10.4%, Tarsus 8.2%.

Age of Onset.   This factor cannot be determined
accurately for spinal caries, as the disease is always
present for some time before the actual appearance of
symptoms, and this preliminary period cannot be
ascertained.   Potel estimates it at 3 - 7 months for
children. [x.]   The nearest approach possible to the age
of onset is given by the age of onset of symptoms, and
even this is often a matter of considerable indefiniteness.
Again referring to Whitman's statistics;   in 1,259
consecutive cases of tuberculous spine, he gives the
following as representative of the ages of onset. [xi.]

Age.	Percentage.
11 - 20 years	7.2
21 - 30 "	3.5
31 - 50 "	2.6
over 50 "	0.8

Among the patients under treatment in St. Luke's
Hospital during 1924-25 the following figures represent
the ages of onset of symptoms, those in whom the age of
onset was below 16 years being excluded from the
analysis:-

Age.	Percentage.
16 - 19 years	27.2
20 - 24 "	30.4
25 - 29 "	17.6
30 - 39 "	18.4
40 - 49 "	3.2
over 50 "	3.2

Trauma. The association of injury with the onset of
symptoms is frequently put forward by a patient, and it
is apparent that there is a general belief among these
patients, that spinal disease is the result of an injury.
In describing their early symptoms some patients even
express surprise that they should have developed Pott's
disease, because they cannot remember having ever injured
the spine. When such an attitude towards the cause of
the disease is prevalent, it is not surprising that many
patients associate an injury with the onset of symptoms.
Such a state of affairs detracts greatly from any value
which might otherwise result, from the apparent association
of a previous injury. Among the 70 patients whose
histories I have investigated, there were only 9 who gave

definite reference to injury occuring prior to the first
symptom, the remoteness of the injury varying from 6
months downwards.

In comparison with this it is interesting to note
that several patients gave a history of illness immediately
antecedent to the onset of symptoms.   Pleurisy with
effusion was the illness in 5 cases, influenza in 4 cases,
and childbirth, which may be included here, in 3 cases.

With regard to pleurisy there seems quite a noticeable
association with spinal caries in the adult.   F. Capelle
has drawn attention to this in his thesis on lumbar spinal
caries in adults; he records that out of a series of 118
patients, there were 27 who had pleurisy at varying
intervals before the beginning of spinal trouble; 14 of
these pleuritic cases were with effusion, and 13 were
dry. [xii].   As Capelle rightly points out, the latter are
of doubtful significance in the history of the patient,
as an indication of pleural affection; as it is not
infrequently found that a diagnosis of pleurisy is
based on the early symptoms of Pott's disease.

Although there are only 5 with a history of
antecedent pleural effusion in my series of 70 cases,
yet in 13 additional cases pleurisy with effusion
developed during the course of the spinal disease.

Apart from these pleuritic cases, there were 9
others in whom chronic phthisis was a complication,
making a total of 27 cases showing evidence of pleural,
or lung, affection in association with the spinal disease.

In 14 cases the spinal caries was associated with
other non-pulmonary tuberculous lesions, some of which
were antecedent to, and others complications of, the
spinal lesion.   Only 6 of these, however, were apparently
free from pulmonary affection.

Region of Spine affected.   In adults there is a very
definite predisposition for affection of the dorsi-
lumbar region of the spine.   According to Potel,
suboccipital disease is met with chiefly in adolescent and
young adults, the maximum frequency of incidence occurring
about the age of 18. [xiii].   During the years 1924-25
there have only been two cases of suboccipital disease
in St. Luke's Hospital.   I have arranged graphically
(Fig.1.) the frequency of affection of the different
vertebrae, the figures being obtained from 124 cases
in St. Luke's Hospital.   In each case the diseased
vertebrae were identified by X Rays.
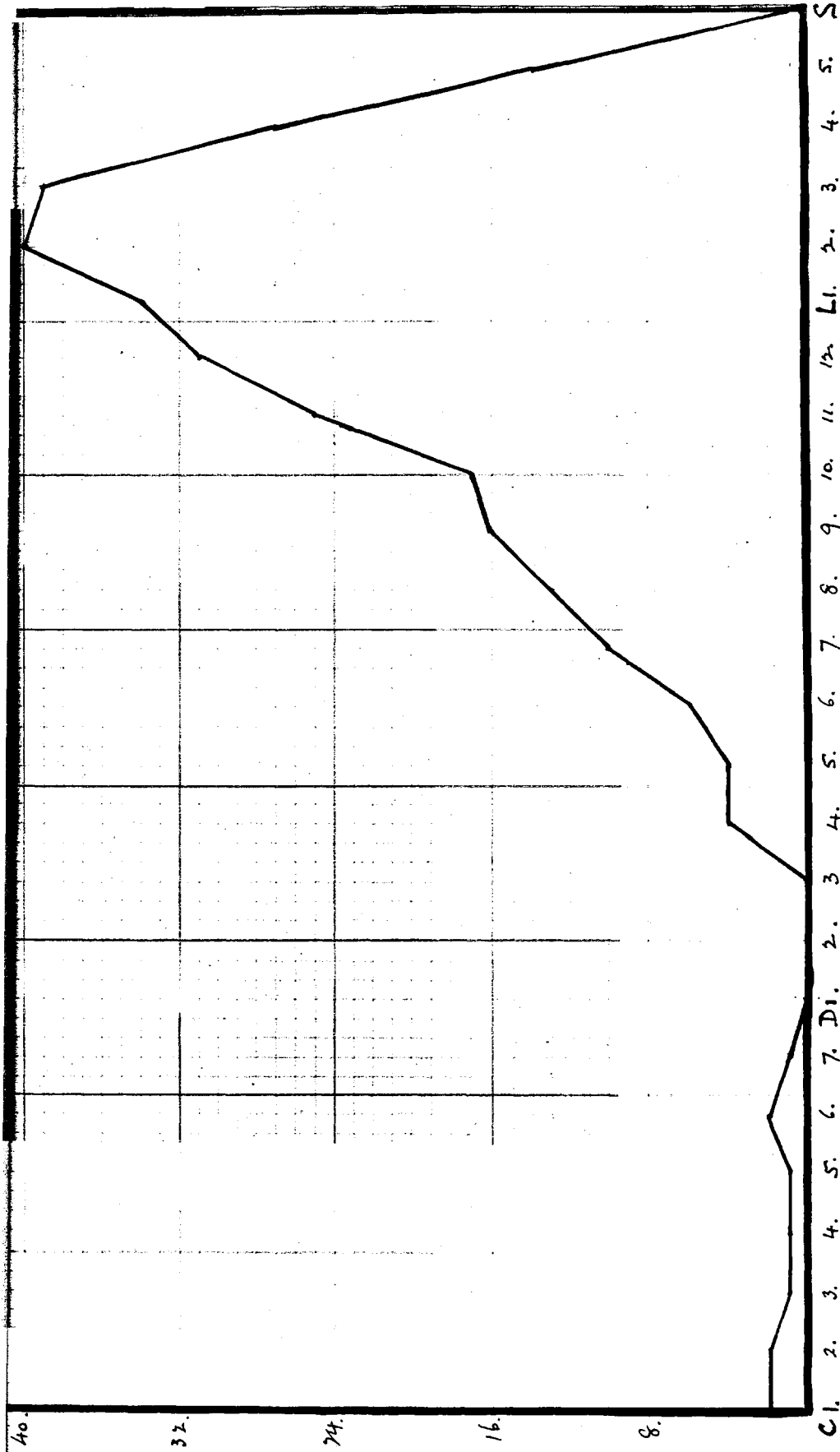
Fig. 1. The frequency of affection by tuberculosis, of the different vertebrae, from a series of 124 adult cases of Pott's disease.

P A T H O L O G Y.

The tubercle bacilli reach the vertebrae by way of the blood stream, in which they constitute small emboli.

When tuberculous disease affects growing bone, the organisms appear to show a predilection for cancellous bone in the immediate neighbourhood of the epiphyseal lines.   Consequently in patients up to the age of 25 years, the primary focus is usually placed in the vertebral body, close to one or other epiphyseal plate.   After the age of 25 when the epiphyses are finally united to the body, there is no longer a zone of increased vascularity near the epiphyses, and the bacilli.do not, therefore, show any special tendency to settle in one part, rather than another.

A periosteal form of vertebral tuberculosis is described as the form most frequently encountered in adults. [xiv].   It is stated that the disease begins on the deep surface of the periosteum, on the anterior aspect of the vertebrae, spreading extensively and causing superficial caries.   It is held, however, by Nichols and others, that practically all cases of bone and joint tuberculosis show evidence of osteal origin, this conclusion being derived from the examination of specimens removed at operation, or at autopsy. [xv].   It would seem probable that, in those cases which appear to

be periosteal in origin, one or other of the apparently
superficial erosions, observed in this type, is the site
of extension of the primary focus from the cancellous
bone to the surface.

In whatever part of the vertebral body the primary
focus is placed, the immediate results are the same, a
local, low-grade, inflammatory reaction.   An acute
reaction is sometimes met with, but in the adult is very
rare.   The general tendency of the tuberculous infection
is to cause destruction of bone, and abcess formation.
The process may be checked at any stage, either temporarily
or permanently - the latter event resulting in a cure of
the disease.

Throughout the course of the disease, there is a
continual strife between the bacilli and their toxins on
the one hand, and the body resistance on the other. The
state of balance between the two forces fluctuates, but
seldom to any great degree on one side or the other, until
the terminal stages.   In untreated cases the balance is
more often on the side of the bacilli, and so the disease
progresses.   It is because of the mildness of the
reaction induced, and the continued maintenance between
the two forces, of a state seldom far from equilibrium,
that tuberculous disease of the spine presents usually
such a chronic appearance.

The progress of the bacillary invasion is marked by destruction of tissue; the activity of the body resistance takes the form of 'endothelioid' and lymphocytic proliferation, with subsequent fibrosis. These two processes of tissue destruction and fibrosis, occur simultaneously - the one being more prominent than the other, according as the corresponding force is in the ascendancy.

PRIMARY FOCUS. It is difficult to determine whether the disease begins with a single focus, or whether several foci are established about the same time, and subsequently are active. The mode of development of the disease prevents its recognition sufficiently early for specimens, showing the first pathological changes, to be obtained. N. Senn states that the tuberculous process in the vertebrae is characterised by the multiplicity of the primary foci, either in one vertebral body, or scattered over several, and that in some specimens 20 - 30, and even as many as 100 separate foci can be demonstrated.[xvi] Whether this last was in a case of miliary tuberculosis is not recorded.

The bacilli being blood borne, it is reasonable to assume that the organisms are lodged in several parts of the bone about the same time, but that these all form primary foci for the development of spinal caries, the subsequent character of the disease seems to disprove.

As it is usual for the disease primarily to involve
a part of one vertebra, it seems probable that the
primary focus is single, or that several bacillary
emboli lodged in vessels closely adjoining each other,
proceed to form minute tubercles which coalesce, so
that by the time the diseased area is detectable
macroscopically, the focus appears to be single.

The process advances by the formation of tubercles
which coalesce, and also by tuberculous infiltration.
The bacillary toxins act on the vessel walls, and cause
their occlusion by proliferation of the intima, and by
thrombosis.   The endothelium lining the lymph spaces
proliferates, forming large numbers of endothelioid cells,
apparently in specific response to the tuberculous toxins.
Also there is a lymphocytic infiltration in the tissues
surrounding the bacilli and endothelioid cells.   Owing
to the unyielding character of the bone, and to the
lowness of the reaction, there is little serous exudate.

As a result of the direct action of toxin, and the
deprivation of blood supply by thrombosis, the central
part of the affected area undergoes degenerative changes,
and a caseous mass is formed, derived from necrotic
tissues and degenerated endothelioid cells.

The bacilli are most active at the periphery of this
mass, where they continue to form their toxins, and
penetrate into the surrounding tissues wherever the

resistance is weakest.   Some of the organisms pass by
way of the lymph spaces to adjacent parts, and form
fresh tubercles, which grow and coalesce with the
original focus.

In the vertebrae it is noteworthy that the path of
least resistance to the progress of the disease is
always towards the anterior, and antero-lateral aspects
of the bodies.   This may be partially accounted for by
the fact, that the peripheral layer of compact bone is
thicker on the posterior, than on the anterior aspect
of the vertebral body.   Sooner or later, and almost
always before the posterior surface is reached, the
tuberculous process involves the anterior layer of
compact bone, and then the deep surface of the periosteum.

The epiphyseal junction in growing bone offers
considerable resistance to the vertical extension of
the disease process, but this is not apparent after
the epiphyses have finally united with the body, about
the age of 25 years.   Either by direct contact spread,
or after the periosteum has been involved, the nearest
intervertebral disc is attacked.   This offers very
little resistance to the disease, which then extends to
the next vertebra.   C. J. Marshall and A. Piney consider
that the intervertebral discs resist erosion for a very
long time. [xvii.]   J. G. Adami, however, holds the
[xviii] opposite view, and both from X ray appearances in the

living, and from post-mortem specimens, it is evident
that the intervertebral cartilages are destroyed far
more rapidly than the bone.

The caries is most commonly localised to two
adjacent vertebrae and the disc between them.

Caries sicca, characterised by the absence of
abscess formation, is described in connection with
Pott's disease, but it must be very rare.   In 100
autopsies, made by Lannelongue, only one was found
without an abscess. [xix].   For all practical purposes,
it may be assumed that an abscess forms at some stage
of the disease, the abscess consisting of a collection
of necrotic material and serum.

The exudation of serum is never marked until the
bacilli erupt on the surface of the bone, and the amount
varies considerably in individual cases, according to
the virulence of the infection.   As the abscess increases
in size on the anterior and antero-lateral surfaces of the
affected vertebra, it strips up the periosteum and
superjacent ligaments and fasciae, in vertical and
horizontal directions.   The thin periosteum may soon be
destroyed, but the ligaments and fasciae resist the
extension of the disease, and as the result of
inflammatory reaction, are thickened to form a stout
wall to the abscess.   By the enlargement of the abscess,

the adjacent vertebrae are subjected to the action of
the tubercle bacilli, and superficial erosions of the
bone frequently take place, and the discs are more
extensively affected.

The abscess tends to extend more in the upward,
than in the downward, direction, and the bacilli remain
concentrated in the immediate vicinity of the original
focus.   Gravity appears to influence the distribution
of the contents of the abscess, the upper part being
mainly serous, and the lower part consisting of
sedimented necrotic material and bacilli.

The destruction of the bone and discs is followed
by collapse of the vertebrae, as a result of the pressure
above and below the lesion, induced mainly by gravity,
and partly by muscular action.   This collapse usually
occurs gradually but may take place suddenly.   As the
anterior parts of the vertebrae are destroyed, the
vertebrae collapse, and an angular projection in the
back is the result, varying in acuteness with the degree
to which the diseased area is localised.

The tuberculous process may extend to involve the
dorsal surface of the vertebral body, or may reach the
dorsum by way of the intervertebral discs.   An abscess
may form beneath the posterior common ligament, and
extend on either side of this ligament in the epidural
space.   The veins beneath the posterior common

ligament may be involved in the inflammatory process,
and thrombosis may follow in the smaller veins, while
the flow of blood in the larger veins is retarded by
the mechanical pressure of the abscess.   This
obstruction to the circulation results in congestion
of the veins of the cord, nerve roots and epidural
space; œdema of the cord may ensue.   Enlargement of
the abscess is limited by the dura, which offers a very
effective resistance, although pachymeningitis externa
may be present.

The prevertebral abscess usually shows a tendency
to'wander", taking the line of an adjacent nerve or
artery as guide, and being controlled in its progress,
by the fascial compartments with which it becomes
associated.   The abscess, as it tracks from one part
to another, is always enclosed in a well defined wall,
formed as a result of the reaction incited in the adjacent
tissues by the bacillary toxins - this reaction
consisting of a cellular proliferation, and lymphocytic
infiltration.   Perforation of the abscess wall, and
escape of the pus into the internal body cavities, is
very rare, and therefore the following case is of
interest:-

E. F.   .Aet.23.   This patient was admitted to St.
         Luke's Hospital, suffering from spinal caries
         affecting the 9th., 10th., and 11th. thoracic
         vertebrae.   The deformity was mild, and there

was a right lumbar abscess discharging by a sinus
in the right flank.   The chest was not affected.

On 16th. January 1925, he complained of an
attack of acute abdominal pain located mainly in
the appendix region;   the abdomen was distended
and tympanitic, with general slight rigidity.
The temperature was 101°F, and the pulse rate
120.   A flatus enema was administered with
negative result.   By the 20th., the abdominal
pain had almost entirely gone but the distension
persisted.   Pain was felt in the right lumbar
and hypochondriac regions, on deep respiration
and coughing;   also there was complaint at times
of a choking sensation, when the respirations
were sighing in character.   Pyrexia persisted.
On examination of the chest, moist rales were
heard over the left base.   On the 25th.,
examination of the chest and abdomen by the
fluorescent screen showed the former apparently
normal - there was no fluid, or other abnormal
shadow.   The abdomen was filled with gas.
Nothing was detected by laryngoscopy.   Next day,
examination of the chest revealed dulness at the
right base, where the breath sounds were absent,
but coarse rales detected.   At the left base the
breath sounds were weak and accompanied by moist
rales.   Vocal resonance was unmodified.   The
left border of the area of cardiac dulness was 1"
outside the left nipple line, and the right border
was mid-sternal.   The apex beat was forcible, and
on auscultation a V. S. murmur was heard at the apex,
but was not conducted.

The pleural cavity was tapped on the right side
in the 9th. intercostal space, but only 1 cc. of
serum was obtained.   On the 31st. January, he
complained of severe pain behind the sternum, of
sudden onset, and on the next day, the pain was felt
on the right side of the chest anteriorly.
Examination of the chest showed dulness all over the
right side, with the breath sounds harsh and tubular
in front, and absent behind.   The patient was
moderately cyanosed.   He became rapidly weaker;
dyspnoea was marked and cyanosis increased.

Death occurred on 3rd. February.   Pyrexia
from the onset until death was regularly intermittent,
ranging from 99°F. - 103.5°F.   Sweating was profuse
and the abdominal distension persisted throughout,
being unaffected by enemata, or by the administration
of pituitrin and physostigmine.

POST MORTEM.

The fronts of the 9th., 10th., and 11th. dorsal
vertebrae were fused together, there being no
evidence of intervertebral discs.   A medium sized
abscess occupied the left psoas sheath, but there
was no evidence of a right psoas abscess in front
of the muscle.   A prevertebral abscess extended
as high as the 4th. dorsal vertebra, and a few
superficial erosions were found in the bones above
the primary focus.

On opening the right pleural cavity it was
found to be filled with a large quantity of fluid
under pressure - mostly clear, greenish serum,
with a sediment of pus.   The parietal and visceral
layers of the pleura were shaggy and purulent.
The right lung was collapsed and solid; the left
lung congested; there was no evidence of pneumonic
tuberculosis on either side.

Opposite the disc between the 7th. and 8th.
dorsal vertebrae the pleura was greatly thickened,
and adherent to the wall of the prevertebral abscess,
and presented a small pathological opening connecting
the abscess with the pleural cavity.

In the abdomen, the caecum and colon were
greatly distended as far as the sigmoid; there was
no apparent mechanical obstruction.

Marshall and Piney state that a psoas abscess causes
                              xx.
rapid disintegration of the muscle.   Considering the

rapid and complete recovery of power in the muscle after

a psoas abscess has been absorbed, it seems unlikely that

destruction of the muscle takes place to any extent; and

further, such post-mortem specimens as I have examined

have shown no apparent destruction of muscle, even in

cases of long standing psoas abscess.   This is, doubtless,

due to the reaction of the connective tissues forming a

limiting wall to the abscess, and thus protecting the

surrounding tissues.

The tendency to "wander" from a prevertebral position, is more marked in abscesses in the cervical and lumbar regions, than in the thoracic (excluding abscess from disease of the 11th. and 12th. thoracic vertebrae), although in this region the abscess may follow the intercostal nerves; in the cervical and lumbar regions it is unusual for the abscess to remain long confined by the prevertebral fascia.

The wandering abscess tends to become subcutaneous eventually, and, if left untreated, the skin is involved in the inflammatory reaction, and eventually gives way before the continued toxic action of the bacilli, and a sinus is formed. It is possible that saprophytic cocci, in the deeper layers of the skin, infect the abscess secondarily before sinus formation, and may play their part in causing the skin necrosis. In any case, after a sinus is formed, secondary infection takes place inevitably. Secondary infection of the tuberculous abscess is followed by a greater tendency to tissue destruction, to sequestrum formation, and to the development of secondary abscesses which point superficially and form further sinuses. A greater amount of toxin is liberated in the circulation and there is a distinct liability to amyloid degeneration of the spleen and kidneys, etc.

The collapse of the vertebrae tends to limit the

activity of the organisms, and healing may occur in untreated cases, but more often in patients under treatment.   As in all tuberculous lesions, granulations tend to be exuberant, and in the spine they may be troublesome if present on the dorsal surface of the vertebral bodies; here they may interfere with the circulation of the cord and give rise to paraplegia.

As healing takes place the necrotic material is gradually replaced by granulations, and new fibrous tissue is formed.   The bone-cells enter into formation of these granulations to a very limited extent in uninfected cases; where secondary infection has taken place, however, and has been in existence for some time, the increased reaction leads to the laying down of new bone by the osteoblasts.   The exuberance of the granulations results in the new bone being present as osteophytic outgrowths, which may even form connecting osseous bridges between adjacent vertebrae.   This is well shown in the accompanying print. (Fig.2.)

The absorption of the abscess may occur at the same time as the healing of the bony lesion, or may be postponed until later.   Absorption may take place rapidly even without interference, as for example, by aspiration; and if resolution be complete, all that remains is a fibrous thickening to mark the site of the abscess.
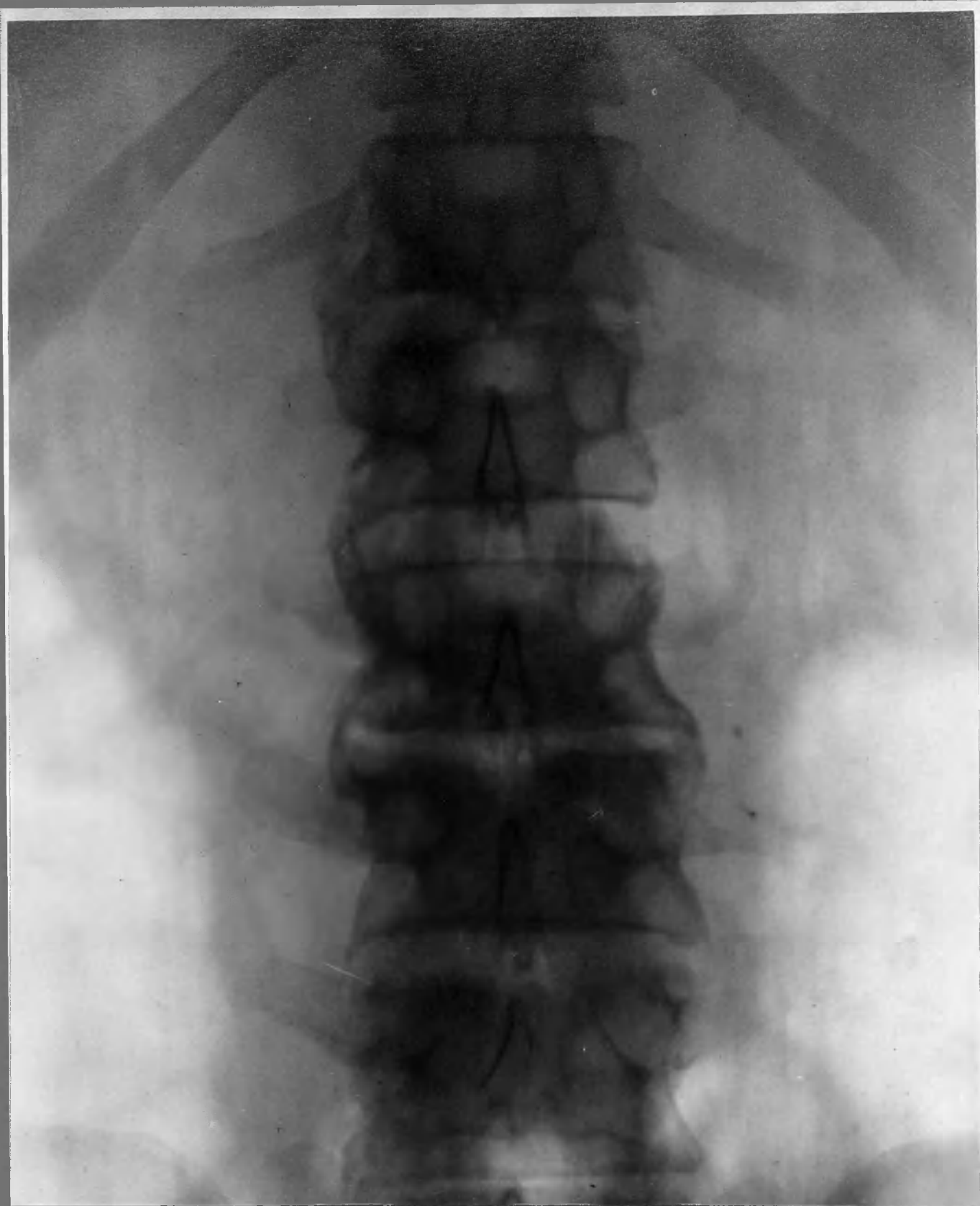
Fig. 2. Case No.31. W.H. Primary lesion affecting the 2nd. and 3rd. lumbar vertebrae. Secondary infection. Osteophytic bridging between successive vertebrae.

S Y M P T O M S.

The early symptoms of spinal caries in the adult
are so insidious in their development, that it is only
when the disease is moderately advanced, that the
patient's complaints and the clinical signs take
definite form, in a way that renders it podsible to
make a diagnosis with any degree of assurance.   Further,
the indefiniteness, and, in some cases, the triviality
of the earliest symptoms, prevent the patient from
seeking medical advice until the disease has been
established for some time.

The development of the classical symptom -
deformity -, in the adult, is a slower process than in
the child;   so much so that Ménard said that it takes 8
years before the presence of Pott's disease in the adult
can be recognised.   xxi.   In the child the bone is not
so dense, and offers less resistance to the disease;
consequently the destruction is more rapid, collapse
occurs earlier, and so it is rare to find the disease
producing symptoms in the child, without the presence of
a readily detectable deformity.   In the adult this is
not, as a rule, the case;   the symptom of pain is
present considerably before the development of an
appreciable gibbus.   There are, of course, exceptions
to this.

It is evident from a study of the histories given

by the patients whom I have questioned, that some of the symptoms described by them are not necessarily those of which they have made complaint to their medical attendants. The present knowledge of his disease naturally colours the patient's story, and each one has doubtless endeavoured to think back, and bring into prominence every minor symptom which might possibly have reference to spinal disease.   This tends to obscure the important points in some cases, but even so, there remains a definite conformity to certain groups of symptoms, in the great majority of cases.

I will now describe in general outline, the usual development of symptoms as encountered in adult spinal caries.   The account is based for the most part on the patients' histories, and partly also on actual observations of patients under treatment in St. Luke's Hospital.

The lower dorsal, and the lumbar, are the most commonly affected regions of the spine in adults, and the following description refers more particularly to these regions.

The onset is so gradual that the patient can rarely fix a definite time when the symptoms were first noted. A slight aching in the small of the back is experienced. This aching is not associated with any particular movements, and shows no special periodicity at first.

It is only noted when the patient's attention is not otherwise occupied.   Were it not for the subsequent development of apparent spinal trouble the achings would be forgotten, as they are not regarded with any significance at the time.

Mild backache may persist off and on for weeks, or, even months, and then the patient begins to find his back gradually becoming troublesome.   The backache becomes more severe, and is associated with definite movements and periods.   It is now described as a pain, usually felt right across the small of the back, sometimes to one or other side of the spine, but not in the spine itself.

The movement most constantly associated with the pain is that of rising from bed in the morning;   it is usually the earliest form of movement to be associated with the pain, and is usually also the most severe of the pains felt at this stage of the disease.   The pain is always characterised by a gradual easing with exercise, so that after moving about for a few minutes the pain passes off altogether.   As time goes on, however, it is observed that the pain takes longer to pass off.

About the same time, the patient notices that towards the end of the day the back aches rather severely, and continues until he goes to bed, thereafter the ache gradually leaves him so that he is not kept awake.

Sleep is undisturbed and he remains free from pain until getting up the next morning. As with the morning pain, so it is observed with the evening pain that, as the disease progresses, lying in bed takes longer than at first to ease the pain.

Then pain in the back is noticed in connection with movements such as stooping. During this movement the pain is equally severe in bending down and in rising again, unless some weight is being raised, when the lifting greatly augments the pain. Consequently, such movements as bending down to tie up the shoe-laces, or to lift anything from the ground, are avoided. Severe pain in the same region is also felt when rising from a chair, and this is the more marked the longer the period during which the patient has been sitting, before getting up from the chair. Several other common movements are liable to be causative of pain, for example, going up and down stairs, more particularly the former; supporting a weight in front of the chest, or on the bent shoulders.

All these are movements which tend to produce anterior flexion of the spine, and an increased load to be supported by the extensor muscles of the back. In spite of these pains the patient is able to run on level ground, but does not willingly engage in vigorous exercise.

Associated with the painful movements, a certain stiffness of the back is sometimes observed by the patient.

This stage of the disease may be continued over a period of many months. The patient consults his doctor and a diagnosis of lumbago, myalgia or muscular rheumatism is made, and liniments and massage are ordered. As a result of this treatment the pains are alleviated to a slight extent, but they recur with undiminished severity, and rest is advised. This treatment is followed by a distinct improvement; the pains disappear and the patient is, and the doctor may be, satisfied at the result; but soon or later, usually soon, after resuming activity the pain returns, and a further period of rest is ordered with equally satisfactory result. This goes on for a considerable time, and also there are periods of varying length during which, even in untreated cases, there is practically no pain. These remissions are followed by return of pain with increased severity.

A further feature is noted by the patient in that whenever he is jolted as, for example, by tripping over a stone, pain is induced in the back, and sometimes in the spine itself.

In addition, a new kind of pain develops which is more severe as a rule than the pain in the back, but may start as a slight aching. It is neuralgic in character, and is invariably induced or aggravated by movements of

the spine, such as twisting or bending.   This pain is
seldom located in the small of the back, but is felt in
one of several places according to the region of the
spine affected,   e.g. the flank, or iliac region of the
abdomen, or the front of the thigh, or over the buttock.
The pain may be localised, or felt throughout the course
of a cutaneous nerve.   After a short time the neuralgic
pain becomes very resistant to treatment;   it may be
induced by the slightest movement, and is often
accompanied by muscular spasm.

The pain in the back persists, but takes a secondary
place, and gradually comes to be disregarded as the
neuralgic pains become more insistent.

Soon after, there appears a swelling in the lumbar
region or the groin, often associated with a cessation of
the pains.   The patient goes to his doctor and points
out the swelling, which is recognised as an abscess;
the patient is examined, stripped, and a deformity of the
spine is detected;   an X ray examination is ordered;
the diagnosis is confirmed and recumbency instituted.

I have described the general course of the disease
going on to the clinical appearance of an abscess, as
this is the commonest mode of evolution, before the
disease is diagnosed.   Not much less frequent, however,

are the cases in which the disease is only recognised
when the patient complains of the appearance of a bony
prominence over the spine.

The variations from the type I have outlined are
many, and I will refer to some of them when considering
the symptoms in detail.

The symptoms of Pott's disease may be summarised
as follows:-

       (1)   Pain in the back.

       (2)   Pain on jarring of the spine.

       (3)   Neuralgic pains.

       (4)   Abscess.

       (5)   Deformity.

       (6)   Additional symptoms.

1. <u>Pain in the back.</u>   This may never be present in patients
who come for treatment, but would probably develop later
if the condition remained undiagnosed.   The symptom may
appear after abscess and sinus formation, but is most
often the earliest cause of complaint.   In my series of
70 cases this symptom was present in 51 cases, and in 45
of these, it was the initial symptom.

The pain may vary from a slight aching in the
earlier stages to a severe sharp pain.   It is usually
insidious in onset, but may appear suddenly.   The mild
aching is seldom the subject of complaint, being 'the

sort of ache anyone gets at the end of a tiring day',
as one of my patients described it.

There may be apparent a seasonal variation, the
pain being worse in wet weather, and it is subject to
remissions of varying duration, which tend to be less
frequent, and more brief, as the disease progresses.

The movements commonly inducing the pain have been
described already.   The way in which these movements
are performed also modifies the character of the pain -
for example, when rising from the sitting position is
attended by pain, the latter is sharp if the movement
be performed quickly, and a dull ache if rising slowly.

As pain in the back is usually the first symptom
of spinal caries in the adult, it becomes of prime
importance to be able to recognise its cause.   When an
abscess or gibbus has developed, the diagnosis is
comparatively easy, but when pain in the back is the
only symptom, the difficulties are great.   It is by
the diagnosis of spinal caries at this stage, that an
increase in the number of early cases submitted for
treatment, can be obtained, and therefore this symptom
requires careful consideration.

Although the pathological processes at work in
spinal caries are known, yet it is very difficult to
determine the cause of associated pains.   The

multiplicity of structures intimately associated with the spine, both anatomically and functionally, confuse the issue as to which one is responsible for the pain. The structures in which the painful stimuli may arise through being primarily involved in the disease in its earlier stages are

    a.   Bone and periosteum.

    b.   Prevertebral ligaments and fasciae.

    c.   Spinal cord and nerves.

a.   <u>Bone and Periosteum.</u>   Pain in connection with bone disease and particularly with disease of the vertebrae, is a very inconsistent factor.   When the shaft of a long bone is affected by acute infective osteomyelitis, the pain is usually very severe - according to Nichols it is the most intense pain with which we are familiar.[xxii.] Acute osteomyelitis of the vertebrae, however, may exist without any indication of vertebral origin beyond a contraction of the psoas (when the lumbar region is affected).[xxiii.]   In erosion of vertebrae by an aneurism, severe dull aching pain in the back is experienced. Simple tumours of bone are painless; also, periosteal sarcomata seldom cause pain in the early stages, but a centrally arising sarcoma is painful; secondary carcinoma of bone may be without symptoms until pathological fracture takes place, but this event is usually preceded by a dull ache.   Pain due to tuberculosis of bone is a very variable symptom, and more often it is absent or very slight.

The possibility of pain arising in bone is evident from the experiments already referred to, in discussing the nerve supply of the vertebrae. It is clear, however, from a consideration of the presence, or absence, of pain in various diseases of bone, that the symptom does not necessarily accompany bone destruction by disease. The necessary factors for the production of bone pain would seem to be a certain degree of pressure on the nerve endings, and a certain degree of rapidity in the development of that pressure. It has been found by many observers, experimentally and clinically, that constant pressure on a nerve or nerve ending may be unattended by pain, but that a more or less sudden increase or decrease in pressure, produces a painful sensation.

Where tuberculous disease affects the cancellous bone of a vertebra, the process is so chronic, and increase or decrease in pressure on the endosteal nerve endings is so gradual, that the pressure may be considered as constant; also the rigidity of the surrounding compact bone, and the limited range of movement possible, relative to surrounding structures, guard the affected area from external influences which might affect the degree of pressure.

A sufficiently high pressure, rapidly produced, may conceivably be produced in acute cases, to cause bone

pain, which is felt by the patient as a dull ache over the lesion.   These cases, however, are rare and it seems that in the usual chronic case, bone pain is not induced.

If it were to be assumed that the pain in the back under consideration is caused by the bony changes alone, we should expect a still greater proportion of cases starting with this pain as a first symptom, since all cases have more or less similar pathological changes taking place in the bone.   Also the pain would have to be considered as a referred pain, being never located by the patient in the bone, but at a lower level than the lesion, and at the sides of the spine.   Were this the case, we should not expect pain to be referred always along the posterior primary divisions of the spinal nerves.

A fact which I have noted in my series of cases, and which seems to me to negative the origin of painful stimuli in the bone and periosteum, is the greater frequency with which the thoracic disease rather than the upper lumbar disease, is associated with pain on coughing or sneezing.   The diaphragm is attached to the bodies of the upper lumbar vertebrae, and when the bone and periosteum of these vertebrae are involved in disease we should expect the sudden and powerful contractions of the diaphragm associated with coughing and sneezing, to

produce a particularly painful sensation, if the affected
tissues were sensitive to pain.   Such a sensation is not
observed.

b.   <u>Prevertebral Ligaments and Fasciae</u>.   When the tuberculous
material erupts on the surface of the bone, these form the
anterior wall of the resulting abscess.   Whether the pain
in the back arises before this stage cannot be definitely
determined, but as such a stage occurs in all cases, the
possibility of pain being due to involvement of the fasciae
and ligamants in the dieeased area, must be considered.

In considering this possibility, we have again to
look to the analogy of the response offered to tuberculous
abscesses by fascia in other parts of the body.   In all
such the abscess material tends to follow the fascial
planes, so that in most cases the fascia forms part of
the wall of the abscess.   Yet in none of these is pain
felt as a rule;   only when the abscess is retained under
considerable tension, is pain experienced.   It may be
assumed that in the case of prevertebral abscess in
Pott's disease the same conditions hold good - there is
absence of pain due to the abscess itself unless the
tension, under which it is confined, is excessive.   In
acute cases such a condition may possibly arise, but
not in the average case where the abscess develops slowly.
The existence of pain in the back, even when the abscess
has tracked away from the spine, and is under no tension

at all, eliminates the fasciae as the cause of the pain.

c.   <u>Spinal Cord and Nerves</u>.   The presence of pain in the back where invasion of the vertebral canal has never occurred negatives the possibility of involvement of the cord being the cause of the pain.

The region in which the pain is felt is supplied by the posterior primary divisions of the spinal nerves, and where the abscess is confined prevertebrally, it is difficult to understand how these nerves could be involved in the disease process.   We should rather expect involvement of the anterior primary divisions to lead to pain in the distribution of their entaneous fibres, at least before the posterior primary divisions were affected.

The improbability of the pain being referred to the distribution of these posterior primary divisions of the spinal nerves has already been considered.

It therefore becomes necessary to look for the cause of the pain in structures which are secondarily affected by the disease in the bones.   These are

    (a) Postvertebral and intervertebral ligaments.
    (b) Postvertebral muscles.

a.   <u>Postvertebral and intervertebral ligaments</u>.   These structures are not ordinarily involved to any extent

by the tuberculous process, but as a result of the vertebral collapse are subjected to abnormal stress. The movement of the collapse of the vertebrae takes place around fixed points - the intervertebral articulations - so that as the anterior parts of the bodies fall together the corresponding spinous processes tend to separate. If the disease affects one side of the bodies more than the other, and collapse occurs on that side, then the extremities of the transverse processes on the opposite side tend to separate. The degree of separation of these processes is not great, and usually occurs very gradually, but it is a greater displacement than occurs in normal movements, and the interspinous, supraspinous and intertransverse ligaments may be put upon the stretch. Sudden strain on a ligament is always painful, but in cases of spinal caries the stretching force is almost invariably applied very gradually, so that the ligaments are able to adapt themselves to the alteration by slowly stretching, and this probably occurs painlessly.

b. <u>Postvertebral muscles</u>. The association of pain with certain movements, in all of which muscular activity is involved, and the localisation of the pain, by the patient, in the muscular masses on either side of the spine, are suggestive, at least, of the existence of some muscular factor in the causation of pain in spinal caries.

A consideration of the functions of the muscles of the back is of use, in my opinion, in throwing light on the cause of pain in the back in adult cases of Pott's disease.

The most important function of the muscles of the back is the maintenance of the erect posture. The force of gravity continually tends to anteflex the spine, and this is prevented by the action of the extensor muscles of the back.

Voluntary muscular activity, when kept up for any length of time, is soon followed by muscle fatigue, and as the greater part of man's days are spent in the upright position, it is clear that this cannot be preserved by voluntary muscular activity. It has been shown by Sir C. Sherrington that the muscles concerned in maintaining this upright position are in a state of postural, or plastic, tone, this being distinguished from contractile, or phasic, tone in that it is capable of being kept up for long periods without signs of fatigue. xxiv. The late Prof. J. Irvine Hunter has proved that this postural tone is a function of the slender, red muscle fibres of voluntary muscles, which are innervated entirely by non-medullated sympathetic nerves, each muscle fibre being provided with sensory and motor nerve endings. xxv. The muscle fibres which are responsible for the contractile tone of voluntary

muscle are larger and pale, and are capable of much more rapid and powerful contraction than the slender fibres. These larger fibres carry out voluntary movements by their contraction, during the performance of which the slender fibres are inhibited; at the conclusion of the movement the slender fibres establish plastic tone in order to maintain the new position. This tonic action is not attended by any change in length of the slender muscle fibres, which adapt themselves to the length imposed upon them by the lengthening and shortening attending voluntary movement.

Sherrington has further demonstrated that the degree of tension in the muscle during postural activity is very small, and is more or less constant whatever the length of the muscle. xxvl. The tension usually developed is just enough for normal requirements, and any extra load, required to be borne, is maintained by the contractile part of the muscle. The degree of postural tension may, however, be considerably increased to meet exceptional circumstances. The postural activities of muscle are apparently under the control of a nerve centre in the brain, and the work of Hunter seems to indicate the formatio reticularis of the pons as the cell station for this purpose. The ponto-spinal tracts of the cord xxvii. subserve the maintenance of postural activity.

Clinically, the existence of muscular fatigue finds

expression as pain located in the muscles themselves.
A study of the patients' histories, and the clinical
observation of adult cases of spinal caries, have led me
to the conclusion that backache and pain, as experienced
by the majority of these cases, are manifestations of
muscular fatigue, affecting the erector spinae muscles.

The primary cause of this fatigue is probably not
a single factor, but a combination of several:-

     a.   Structural alteration in the spine.

     b.   Reflex muscular regidity.

     c.   Muscle wasting.

     d.   Toxaemia.

a.   <u>Structural alteration in the spine</u>.   From a consideration
of the pathological changes occurring in spinal caries, it is
clear that the collapse which follows the bone and disc
destruction, tends to increase the anterior load to be
borne by the anti-gravity muscles of the back, for, as
A. S. B. Bankart has observed, it is not the function of
ligaments to withstand long-continued strains, it is the
                         xxviii.
function of muscles.

Although the degree of collapse, in the early stages
at least, is slight, yet it cannot be corrected by
muscular action, or checked by ligaments.   The spine
above the lesion is given a forward inclination, thus
advancing slightly the position of the centre of gravity

of the body. The lower down in the spine that this occurs, the greater is the effect produced on the centre of gravity, by reason of the greater proportion of the spine which is thrown forward as a result of the collapse.

To meet this structural alteration in the spine, and consequent advancement of the centre of gravity, the muscles of the back, by increased activity, develop modifications of the existing spinal curvatures which tend to displace the centre backwards.

It is probable that, were no other factors present, the muscles would be able to effect this compensation, as the collapse usually occurs gradually, and the corrective muscular forces would more or less keep pace with the changes in the bone. Other factors, however, are present to prevent the muscles from meeting the extra calls on their power, and perhaps the most important of these is reflex muscular rigidity.

b. <u>Reflex muscular rigidity</u>. This is a direct result of the disease, and is induced in the muscles which act on the affected vertebrae. The degree of rigidity varies with the virulence of infection. The affected muscle is in a state of increased postural tone and this is constantly maintained while the disease is active.

The low degree of tension in a muscle during normal postural activity enables it to continue this activity

for very long periods without fatigue.   When, however,
special circumstances call for the maintenance of an
increased postural tone, then the liability to fatigue
is proportionately increased.   When structural alteration
in the spine occurs as the result of caries, an increase
in the postural tone of the antigravity muscles of the
back is called for to meet the increased load, and to
induce compensatory curves.   The muscles, however, are
already reflexly in a state of increased tone, and this
further call upon their reserve of power, greatly reduces
their relative immunity to fatigue.

In this state of affairs, there develops more and
more a tendency for the contractile portion of the
muscles to be brought into use, for purposes normally
effected by the postural fibres.

c. Muscle wasting.   The reflex wasting of local muscles
which occurs in connection with inflammations of bone
and joints, is apparent only in the later stages of
spinal caries, affecting the muscles of the back.   It
is doubtless present to some extent in the early stages,
but whereas slight degrees of muscle wasting in a limb
are readily detectable by comparison with the other
limbs, no such method of standardising the normal
muscular development is possible in the back.

Such wasting as may be present in the earlier stages,
would tend to hasten the onset of fatigue in the extensor

muscles under the increased strain to which they are subjected.

d.   Toxaemia.   Although the extent, to which toxic absorption in spinal caries affects the general condition, is small, yet the continued mild toxaemia in time produces a gradual reduction of the patient's health.   This, of course, will affect the muscular power too, and thus provide another factor which tends to lower the resistance to fatigue.

The same factor may be observed to exert a marked influence in those cases, to which I have already made allusion, in which the onset of pain was immediately preceded by illness, such as influenza.   Obviously these illnesses would tend to precipitate the manifestation of muscular fatigue in muscles already subject to abnormal strain.

Another factor which has been apparent in the cases which I have investigated, seems to influence the production of backache due to fatigue; and that is the nerve tone of the patient.   Bankart has drawn attention to the association, in the same individuals, of the development of postural deformities and a neurasthenic tendency, which he considers as effect and contributory cause; according to his observations neurasthenia is marked by a dimunition or partial inhibition of postural

xxix.

tone.   In my series of cases those patients

who might be described as being of a sympatheticotonic

type, invariably gave a long history of backaches and

pains.   Presumably in these patients, who are highly

string, and who, through over-activity of the sympathetic

system, are more or less continually maintaining a degree

of postural tone higher than normal, the liability to

fatigue from additional strain on the postural muscles

is increased, as there is not the same reserve strength

of muscle as in the more normal individual.   I have

already referred to the fact that the muscular development

of the back appears to affect the presence of the symptoms

of backache, in that those, who are actively engaged in

work which involves the lifting of heavy weights, etc.,

are specially liable to be free from pain in the back

until a much more advanced stage of the disease, than are

those who lead sedentary lives.

        This explanation of the cause of the symptom of pain

in the back fits in satisfactorily with the various forms

which the symptom may take.   In the first place the

location of the pain, by the patient, is always to the

muscles below the site of the lesion, where it is clear

on mechanical grounds that the effect of gravity on the

muscles would be felt.   Further it is most commonly

observed that, wherever the site of the lesion in the

lower half of the spine, even as high as the mid-dorsal
region, the backache is located in the small of the back;
this is due to the fact that any strain on the back
muscles induced by gravity, is eventually conducted to
the lumbar muscles in the small of the back, which
support the whole of the spine, in the erect position.
In only two cases of my series of 70, was the lesion
above the mid-dorsal level; in one of these the vertebrae
affected were the 4th. and 5th. dorsal vertebrae, and
this patient's first symptom was pain in the small of
the back; in the other case the 6th. and 7th. cervical
vertebrae were affected, and in the early stages the pain
was located in the mid-dorsal region.

When the postural tone becomes inadequate there is
an almost constant strain on the contractile fibres -
not a very severe one in the early stages, but sufficient
to call forth pain when additional effort is required on
the part of these muscles.

Stooping is controlled by the extensor muscles of
the back, and rising to the erect position is the result
of their contraction - both these movements, causing an
increase in the work required of the muscles, may induce
pain.

Rising from a chair is effected by contraction of
the extensors of the spine in conjunction with those of
the hips and knees, and consequently where these muscles

are fatigued pain is induced.

The pain felt towards the end of the day, in these cases of Pott's disease, is one of fatigue which passes off with rest.

The pain experienced on rising from bed in the morning is that of rested muscle still showing the effects of fatigue. A similar state is often found in one who indulges in some unusual form of vigorous exercise such as a game of Rugby football, and who, after a night's rest, rises with aching pains in all his muscles, these pains passing off to a considerable extent with mild exercise.

The pains of muscle fatigue may manifest themselves over long periods - months and even years - and usually with remissions of varying duration. The cause of these remissions, when the patient is free from pain, is the reduction of any one, or more, of the factors which I have considered as being contributory to the production of the muscle fatigue. The disease may be temporarily checked leading to a less toxic state, and also a diminution in the degree of muscular rigidity; the muscle may be able to establish compensatory changes in the spine and the pain is relieved for a time. Sooner or later, however, the bacillary activity gains the upper hand, a further degree of bony collapse may occur, and there may be an increase in the toxaemia; the

postural activity of the muscles again becomes inadeQuate and pain follows.

Although there are signs of muscle fatigue, yet the muscle has intervals when rest is obtained, during which recovery from fatigue occurs rapidly in the earlier stages, and ability for further work is acquired.   As the continued strain is maintained for long periods, the capacity of the muscle, for recovery from fatigue, is by degrees reduced, and in long standing cases, the muscles may become exhausted and the patient collapses. This muscular collapse was observed in two of my patients.

Jenner Verrall holds that the commonest cause of lumbo-sacral backache is strain thrown on the ligaments of the spine, after muscular effort has failed in the maintenance of an erect spine in cases of visceroptosis. xxx. That muscular exhaustion is present in these cases seems improbable, as the patients are often able to carry out movements involving considerable power on the part of the muscles of the back.

Backache is also an occasional feature of convalescence in cases of spinal caries.   Although the bony lesion may be quiet as observed clinically, and although radiographically there may be shown complete sclerosis and no signs of active disease, yet after the patient has been getting up for a few weeks, he may begin

to experience aching in the back, similar to the aching of which he complained when his back first started to give trouble. This is not, as a rule, an indication that the disease is still active, but merely that the compensatory curves have not yet been fully established, or that the wasted muscles have not yet sufficiently recovered, and are showing signs of fatigue. It is therefore an indication for more careful regulation of the patient's exercise. In any case the aching usually passes off as the muscular development progresses.

Evidence of muscular fatigue in the back may also be observed in children suffering from spinal caries, although the symptoms are not so well defined. Although bone pain is encountered more frequently in these cases than in adults, it seems probable that muscular fatigue may play a part in causing the characteristic attitudes adopted by children with Pott's disease, such as supporting the head with the hands in cervical disease, or supporting the trunk with the hands above the knees in lumbar and thoracic disease. These attitudes are usually attributed to the desire of the patient to relieve the pressure between the diseased bone surfaces, but they might equally, if not more, satisfactorily be explained as attempts at relieving the strain on the fatigued muscles of the back.

2.   <u>Pain on jarring of the spine.</u>   This pain, induced when
the spine is subjected to a sudden jolting, has often
been considered as diagnostic of spinal disease.   The
question of the location of the pain by the patient is
important in this connection.   Simple pain in the back
on jarring is not sufficient to clinch the diagnosis of
Pott's disease.   It is necessary for the pain to be
referred by the patient to the spine itself in these
cases, and always to the same part of the spine, before
a diagnosis can be made with confidence.

This symptom has usually been moderately late in
appearance in my series of cases.   It may, however,
be the first cause of complaint, but in these, as in all
other cases where the symptom is present, pain in the
back on jarring is always accompanied by the pain in
the back of muscular fatigue.   This constant association
naturally leads to a consideration of the possibility of
muscular pain being induced in this way.   In many cases
where pain is merely felt in the back, and in the same
region as the backache pains, the sudden muscular
contraction accompanying the jolting is doubtless the
source of the pain, and not the jarring of the diseased
bone.   R. W. Lovett has referred to pain on jolting as
occurring in the back, in patients suffering from static
xxxi.
backache due to anterior attitudinal strain .
These are purely muscular pains.

Out of 29, of my series of 70 cases, in whom this symptom was observed, in 22 cases the pain was referred to the muscles where the fatigue pains were felt.

In 7 of the cases, however, the pain was felt in the spine itself, and in the region which proved to be the site of the bony lesion.   These pains, referred to the bone itself would seem to be due to the sudden movement of the diseased parts, producing a sudden change of pressure on the involved nerve endings, these nerve endings otherwise being never subjected to such changes of pressure.

The cause of the jolting may be primarily mechanical, or due to muscular spasm, or to a combination of both. Tripping up over an unevenness of ground is a common mode of inducing the pain, another being the generalised muscular spasm which succeeds a false step, as, for example, on making a step up with the foot when no elevation of the ground is present, or moving forward without noticing the existence of a step down.

Another common experience with these patients is that riding on a solid tyred bus, particularly on top, over uneven ground, induces the jarring pain.

The pain, sometimes induced in the back by coughing or sneezing, comes into this category.

3.   <u>Neuralgic pains</u>.   The group of pains associated with

spinal caries, which I have included under this general
heading because of their character, as opposed to the
pain of muscle fatigue, is a very important one.   In
my series of cases there seems to be a very definite
relationship established between the presence of these
symptoms and the development of abscesses.   Out of 34
cases in which neuralgic pains, due to the spinal
disease, were present, in 21 there was a very intimate
connection between the clinical appearance of an abscess,
and the cessation of the pain.   The following case
illustrates this point.

Case No.20.   H. C. Aet.40.   This patient was admitted

for treatment of bilateral tuberculous epididymitis,
having an apparently quiescent spinal lesion of
over 3 years standing, and for which he wore a
spinal support.   He was allowed up wearing this
spinal jacket, but soon began to complain of pain
in the right loin of an intermittent nature.
The spine was considered to be the cause of this
pain, and recumbency was ordered.   The only other
indications of possible activity in the spine were
mild paraplegic symptoms shown by increased knee
jerks, and patellar clonus.   The plantar reflexes
were flexor in response.

During recumbency, he had two or three severe
attacks of pain in the appendix region with slight
tenderness in this region; he gave a history of
having had several similar attacks prior to admission.

After 8 months recumbency in spite of the
persistence of slight intermittent pain in the
appendix region, and the persistence of greatly
exaggerated knee jerks with clonus, the patient
was allowed up wearing his spinal jacket.   The
pain in the right iliac region, and the increased
knee jerks continued, but after about 3 months a
gradual improvement became noticeable.   The
patient became much more steady, less tremorous,
and the pain in the appendix region became less

evident, until on the 27th. October 1925 there was
no clonus elicited, the knee jerks were only brisk,
and the patient stated that the pain was only very
slight.   On examination 16 days later, the patient
declared he had had no pain at all for several days;
there was no clonus and the knee jerks were brisk;
but a lumbar abscess was now apparent on the right
side.   Since then there has been no recerrence of
pain or paraplegic signs.

These neuralgic pains are commonly referred to as

root pains, but whether that is a correct description in

all cases is very doubtful.   Capelle attributes the pain

to pressure on the nerve trunks and roots in the

intervertebral foramina, through dimunition of the size
                                        xxxii.
of the apertures by collapse of the vertebrae.
                                        xxxiii.
Behan also appears to favour this explanation.

J. Collier, however, has pointed out that the proximity

of the intervertebral foramina to the articular processes

prevents their narrowing to any extent when the vertebral
                          xxxiv.
settling takes place.   Compression of the nerve

roots in the foramina as a result of the vertebral

collapse assuredly does not seem a satisfactory explanation

for many of the neuralgic pains, because the latter may be

present in marked degree where there is very little collapse

of the bones, and moreover they may never be experienced

in cases where the kyphotic deformity is great.

It is natural that symptoms of a similar character

occurring in the same disease, should be attributed to a

common, or similar, cause in the various cases, but with

these nerve symptoms a common explanation seems to be

impossible. The only generalisation which can be made
about them is, that the nature of the pains appears to
indicate the causative agent to be pressure on the course
of sensory conducting nerve fibres. The pressure agent
in the majority of cases seems to be an abscess, as
indicated by the frequent association of pain and abscess
already mentioned.

An abscess in the vertebral canal can quite conceivably
account for referred neuralgic pains, and is probably the
commonest cause of girdle pains; it may also cause some
of the unilateral pains. But the cause of the latter
does not usually appear to be dependant on an intraspinal
abscess, but rather on pressure induced extraspinally and
probably at some distance from the spine. This appears
probable from the fact that the localisation of pain
preceding the clinical appearance of an abscess, bears
a direct relationship to the site where the abscess is
going to present.. Thus, in the case of disease of the
lumbar region, the abscess invariably finds its way into
the psoas muscle where the lumbar plexus is situated;
from here the commonest peripheral spread of the abscess
is down the psoas sheath to the groin, or by way of
Grynfeldt's space to the lumbar region; it is significant
that the appearance of an abscess in the groin is
commonly preceded by pain, of a neuralgic character, in
the groin or front of the thigh, while the appearance of
a lumbar abscess is heralded by neuralgic pain over the

buttock.   This last, doubtless, depends on the subcostal
and iliohypogastric nerves which leave the outer margin
of the psoas sheath, and pass outwards in relation to
the space of Grynfeldt, the floor of which they may
pierce near its outer boundary.   The ilio-inguinal
nerve also runs parallel with these two nerves at a lower
level and may have a relation to the floor of Grynfeldt's
space at its lowest angle.   The lateral cutaneous
branches of the last dorsal, and the ilio-hypogastric
nerves, are both distributed over the crest of the
ilium to the skin of the buttock - the region to which
pain is referred when a lumbar abscess is developing.
The pain of an abscess about to present in the groin
is referred to this region, as a rule, in the area of
distribution of the femoral branch of the genito-crural
nerve which bears an anterior relation to the psoas
muscle in most of its length, having pierced the psoas
fascia anteriorly in the abdomen.

The other regions, to which the pains attending
the development of a psoas abscess are commonly referred,
are down the outer side of the thigh in the distribution
of the external cutaneous nerve, which leaves the psoas
at its lateral border to enter the iliacus sheath; and
in the front of the thigh in the distribution of branches
of the anterior crural nerve - this nerve leaving the
psoas sheath at its outer border above the brim of the
pelvis, to lie between the psoas and iliacus muscles.

The form of pain associated with these abscesses indicates some factor, in addition to simple pressure, which takes part in the production of the pain. Behan defines pain, due to simple pressure, as being constant and unaffected by movement;[xxxv] but in the cases under consideration the pain is invariably induced or aggravated by movement, this character suggesting the presence of some inflammatory change involving the nerve. It is conceivable that the nerves may become involved in the inflammatory wall of the abscess, and relatively fixed thereby, thus becoming subjected to changes of pressure by movement. This, however, seems improbable, as one would reasonably expect this inflammatory involvement to occur equally readily among the trunks of the plexus, and the symptoms do not indicate this occurrence. More probable sites of involvement would be formed by the points of perforation of the psoas sheath by the nerves, and this is borne out by the relation of the nerves, which usually show signs of affection, to the psoas sheath, and to the direction in which the abscess tracks. Thus the abscess which is following the muscle to the groin, induces referred pain in the distribution of the genito-crural nerve, which pierces the fascia anteriorly, while the lumbar abscess tracking laterally comes into relation with the last dorsal, the ilio-hypogastric and the ilio-inguinal nerves as they pierce the lateral aspect of the psoas sheath. Probably the

abscess which is to become lumbar enters the psoas more posteriorly than that which is to appear in the groin.

The psoas sheath is thickened in the region of the active abscess and mildly inflamed; the nerve sheaths also may be affected although they are far more resistant to inflammatory processes, than is the fascia of a muscle sheath. Where the nerve pierces the sheath a mild degree of constriction of the nerve takes place due to the reactionary thickening of the fascia, and such perineuritis as may be present increases the irritability of the nerve, and exaggerates any painful stimuli which it may sustain. Movements of the trunk are accompanied by contraction or relaxation of the psoas muscle, which would induce changes of pressure on the abscess by the muscle. These changes of pressure are communicated equally to all parts of the abscess wall, and consequently are felt by the nerve at the relatively fixed point where it pierces the inflamed muscle sheath. Under such circumstances the relief of pain following evacuation of the abscess, or the reduction in pressure by its tracking further afield, is readily understood.

The following are examples of this association of pain and abscess:-

Case No.4.   A. F. Aet.24.   Following an attack of
    influenza, she began to experience pain in the
    left buttock, which was present more or less
    constantly, and noticed when walking.Movement

was always associated with the pain, and at such times the left leg used to 'draw up'. She was treated as sciatica for a few weeks, and hot air baths were administered which relieved the pain somewhat, and reduced the tendency to flexion of the hip. As the pain got better an abscess developed in the left lumbar region, forming a definite swelling. There was no recurrence of pain. In this case there was disease of the 3rd. and 4th. lumber vertebrae.

Case No.13. P. S. Aet.22. This patient was a pensioner, the disability being chronic pulmonary tuberculosis. His first spinal symptom was pain in the right buttock over the region of the dorsum ilii, the pain being sharp and occasional, and induced particularly by stooping. This continued for about three weeks, and he was sent in to an infirmary, where hot fomentations were applied for another three weeks, when a right lumbar abscess appeared and was incised, the patient being subsequently free from pain. The disease was later found to involve the 12th. dorsal and 1st. lumbar vertebrae. The X ray appearance of this patient's spine is shown in Figure 4.

Case No.34. M. H. Aet.27. There was no previous history of interest. After the birth of this patient's second child in 1920, she used to notice difficulty in getting up after sitting in a chair, on account of pain in the back; also she could not stand straight for a few seconds after rising from the chair. Otherwise there was no disability and she was able to follow her usual activities. This condition persisted until October 1923, when she began to notice pain in the right thigh, particularly just above the knee. Also the pain in the back became more constant preventing stooping, etc. She attended hospital for 6 months, the pain continuing, and about the beginning of June 1924, a swelling developed in the right groin. Recumbency was instituted, and soon after the abscess was incised, and thereafter she was free from pain. This patient's lesion was in the 2nd. and 3rd. lumbar vertebrae as shown in Figure 5.

Case No.21. W. O. Aet.16. This man, after a fall in which he hurt his back, experienced backache for several years, off and on, usually induced by stooping. While in the Army he went sick more than once on account of the pain, but received no treatment, being probably looked upon as a malingerer.

Also, after leaving the Army, he consulted a doctor
who said he had lumbago.   After about six years
from the onset he began to notice the aching pain
rather worse, and particularly so, on getting up
in the morning, and on rising after sitting in a
chair.   This state of affairs continued for about
two years, and then he noticed that whenever he was
jolted the pain was severe in the back, so that he
had to give up his usual activities, such as
football; his occupation was that of a baker's
vanman, and he found he had to get down from the
van very gingerly in order to avoid pain.   Then,
after about a week during which he could not stoop
on account of a 'catching' pain in the left groin,
he noticed a swelling there which increased in
size rapidly, but at the same time the 'catching'
pain ceased.   He was admitted to hospital, and
the abscess was aspirated.   The affected part of
the spine was the lumbo sacral articulation, and
the 4th. and 5th. lumbar vertebrae.

There are many cases, however, in which the
involvement of a nerve in the psoas sheath, does not
appear to explain satisfactorily the neuralgic pains
which are present.   Such are the cases of 'girdle pain',
and also several cases of unilateral pains, as for
example in the case already described - No.20 - in which
the association of paraplegic symptoms with the pain,
and their simultaneous disappearance with the peripheral
appearance of the abscess, suggest a common, central
site of origin.

The onset of the girdle pain may be as a unilateral
pain separated from the commencement of bilateral pain
by a variable period - sometimes months, yet it is
difficult to attribute this to successive involvement
of symmetrical nerves peripherally.   In these cases it
seems necessary to invoke the presence of an intraspinal

abscess.   This must evidently occur frequently
without producing symptoms.   The abscess gains
entrance to the spinal canal by direct extension of the
caries to the dorsum of the bodies and discs, or by way
of the intervertebral foramina.

The first effect of an abscess, situated on the
dorsum of the vertebral bodies, is produced on the
venous plexus which is situated there, under cover
of the posterior common ligament.   As a result of
mechanical pressure, and of toxic thrombosis,
obstruction to the venous return is established.
This is the main path of return for the blood from the
contents of the spinal canal, and so there follows
venous congestion of the cord, and nerve roots and
meninges;   the circulation is maintained chiefly by
the intervertebral veins which are dilated to meet the
extra needs.

The movements of the trunk are effected by
muscular contraction, so that contraction or relaxation
of the perispinal muscles accompany each movement.
These muscular changes produce slight displacements in
the nerves in close relation to them, contraction of the
muscles effecting a mild degree of traction on the nerves.
Normally this is too slight a stimulus to take any effect
on the nerves, but when the nerve roots are congested,
they are hyperirritable and so able to appreciate the

slight nerve stretching induced by muscular contraction.
The response to stimulation is more readily induced in
the sensory roots than in the motor roots, and so pain,
rather than motor symptoms, are the result.   The
muscular changes accompanying movements of the spine
are more or less symmetrical, and so the nerve roots
of both sides are stimulated.   Where the venous
congestion affects one root more than the other, the
root pain may be unilateral.

A similar result would be obtained by interference
with the blood supply of the nerve trunk and roots from
without, the abscess entering the vertebral canal by the
intervertebral foramen and constricting the nerve roots
there.

The relief of intraspinal pressure by 'wandering'
of the abscess away from the spine, would readily account
for the disappearance of these root pains, as the intra-
spinal and prevertebral abscesses would be continuous
with each other.   Some such arrangement was probably
present in the case No.20 - an intraspinal abscess
producing unilateral root pain of the 11th. thoracic
nerve, and also causing oedema of the cord with
consequent paraplegia.

Where the degree of congestion in the nerve roots
is very great, the resultant hyper-irritability may be

such that the slightest stimulus results in acute root
pain.

Neuralgic pains, as opposed to muscle fatigue pains,
usually occur as relatively late symptoms, but they are
not infrequently the first evidence of spinal disease,
and may even precede the appearance of fatigue pains.
In 9 of my series of 70 cases, neuralgic pain was the
initial symptom.

The severity of the pain is very variable.   It
may be present as a slight aching, or may be excruciating
and sufficiently severe, if felt in the abdomen, to
suggest the presence of acute colic.   The pains may be
moderately severe and intermittent, but more often there
is a continuous dull pain, subject to paroxysmal
exacerbations.   The latter are invariably induced by
movement, such as stooping, twisting, coughing and
sneezing.   The pain is not infrequently very severe at
night in untreated cases, keeping the patient awake,
and sometimes, if he be restless, waking him out of
sleep.

The localisation of the pain varies with the region
affected and the nerve root or trunk involved.

In the cervical region, neuralgic pains form a
common mode of onset.   Suboccipital disease is
accompanied by radiating pains over the back of the

head in the distribution of the great occipital nerve.
Lower down, pressure on the great auricular nerve may
give rise to neuralgic pains over the mastoid, while in
affections of the lower cervical region, pain over the
shoulders and down the arms are present when the roots
or nerves, from the cervical enlargement, are involved.

It is in the thoracic lesions that 'girdle pain' is
most typically encountered, the pain being referred along
the course of the intercostal nerves of both sides.
The typical 'girdle pain' is felt round both sides of
the chest, but in some cases the pain is only referred
to the regions over the lateral, or terminal, cutaneous
branch.

Disease of the lumbar vertebrae may be accompanied
by bilateral root pains but they are much less common
than in the dorsal region.   They occurred in 3 of my
cases, in which the pains were felt simultaneously and
symmetrically in both legs;   (1) the 11th. and 12th.
dorsal and 1st. lumbar vertebrae were affected, and the
pains were over the back of both hips (12th. dorsal
nerve), and in the upper part of the thigh anteriorly
(1st. and 2nd. lumbar nerves);   (2) disease of the 4th.
and 5th. lumbar vertebrae, and pain down the back of
both thighs (1st. three sacral nerves);   (3) a 2nd.
and 3rd. lumbar lesion with pains shooting from the
buttocks round the outer sides of the hips, and down

the front of the thighs to the inner side of the knees
(2nd. and 3rd. lumbar nerves).   It is of interest that
in all three cases pain was much more marked on one side
than the other, and subsequently in the case of (2), and
of (3), an iliopsoas abscess developed on the side on
which pain was more severe.

The usual referred pains in lumbar disease are
those due to the psoas abscess, and its subsequent
course.   These pains, which are unilateral, I have
already considered.

4.   Abscess.   This may be looked upon as a complication
of Pott's disease, but I have considered it under the
heading of symptoms, because an abscess is invariably
present.

It is only in a certain proportion of cases,
however, that the abscess comes to be recognised
clinically - in 48 of my series of 70 cases.   Of the
remaining 22 cases, 10, all of which were thoracic
affections, showed radiographically the presence of
an abscess, leaving 12 out of 70 cases in which an
abscess cannot be detected.

The prevertebral abscess in connection with spinal
caries may attain to a great size, extending up and down
the vertebral column, stripping the prevertebral ligaments
and fasciae from several vertebrae.   There is, however,

even with the largest abscesses, when not secondarily
infected, very little constitutional disturbance, no
rise in temperature and frequently no pain due to the
abscess itself.

An abscess may, though seldom, be the first evidence
of spinal caries in an adult, but it is very frequently
the first symptom by which a correct diagnosis is made.
In the series of 70 cases, in only 2 was the superficial
appearance of an abscess the first symptom, but in 30
cases it was this symptom which brought about a diagnosis
of tuberculosis of the spine.

Should the abscess become secondarily infected, it
grows at a much greater rate than a simple cold abscess,
and tends to infiltrate the tissues, producing a greater
reaction, local and general.   Pain is usually present
in the region of such an abscess, and remains until the
pus is evacuated.   An elevated temperature is also an
accompaniment of the abscess.

The pus from the cold abscess in Pott's disease
varies in consistency in different cases;   there are
four types commonly encountered.

    a.   The active abscess contains a whitish yellow
           fluid, most commonly of a creamy consistence.

    b.   The abscess in the early stages of resolution
           may be very large, consisting mainly of clear,
           serous fluid of the colour of urine, or with a
           greenish tint.   In the lower parts of such an
           abscess there is found a sediment of caseous
           material.

c.   At a later stage of resolution, the serous
     fluid is largely absorbed, and a pultaceous
     mass of necrotic material occupies the abscess
     cavity.

d.   Another form of abscess is the haemorrhagic
     abscess, from which a chocolate-coloured pus is
     obtained.   In such abscesses the tubercle
     bacilli are relatively abundant, and examination
     of a direct smear of the pus reveals the organisms.
     These abscesses are of more serious import than
     the other types, as they almost invariably proceed
     to sinus formation in spite of all precautions.

The fluid from a cold abscess usually contains
tubercle bacilli, but in varying numbers and distribution.
It is customary in treating abscesses in St. Luke's
Hospital to have a portion, of the material removed at the
first aspiration, examined both microscopically and by
guineapig inoculation.   In 30 of my series of cases, an
abscess was present apparently free from secondary
infection;   examination of these for the tubercle
bacillus gave 19 positive and 11 negative results.

In this connection it is perhaps advisable to refer
to the method of aspirating a cold abscess with a view
to indentifying the presence of Koch's bacillus.   The
examination of a direct smear microscopically is a
tedious procedure, however necessary;   but the probability
of obtaining a relatively large number of bacilli on the
slide, and thus facilitating the search for the organism,
can be enhanced by examining the last drops of pus
evacuated from the abscess at aspiration.   It has been
observed by Dr. W. M. Oakden, the Medical Superintendent

of St. Luke's Hospital, that a larger proportion of positive results, from direct microscopical examination, is obtained by adopting this method than if the first portion of the pus, obtained by aspiration, is examined.

Although all the abscesses in spinal caries form prevertebrally in the first place, their subsequent evolution varies in the different regions of the spinal column.

Cervical.   In whatever part of the cervical spine the abscess may form, it usually is detectable, at some stage, as a retropharyngeal swelling.   When the disease is primarily in the lower part of the cervical region, the abscess tends to track upwards, rather than downwards, and so becomes retropharyngeal.   When it attains a moderate size there may be dysphagia, but before this symptom develops it is usually noticeable that the patient speaks with a nasal twang, due to the imperfect separation of the nasopharynx by the soft palate. This quality of the voice is often quite characteristic.

There is   little tendency on the part of the abscess to perforate the posterior pharyngeal wall, when not secondarily infected, the prevertebral fascia offering considerable resistance to its advancement. The abscess therefore takes a path of less resistance and tracks outwards, behind the prevertebral fascia as

far as the deep surface of the sternomastoid muscle;
it then continues further laterally to form a swelling
behind the sternomastoid, or passes downwards in the
neck under cover of that muscle to become superficial
in the region of its insertion, or in the posterior
triangle of the neck.

When a retropharyngeal abscess has become secondarily
infected there is a tendency to ulceration through the
posterior pharyngeal mucosa, so that the pus may be
discharged into the pharynx.   This may take place
gradually and without attracting the patient's attention.

D. B. Aet.18.   This patient was suffering from
     suboccipital disease of long standing; there were
     several discharging sinuses over the upper part of
     the front of the chest, and another on the right
     side of the neck behind the lower part of the sterno
     mastoid muscle.   He was treated on a plaster boat
     with head piece, and improved considerably.   At
     one stage of the treatment, however, he developed
     albuminuria; on examination about a fortnight
     after this appeared, a small abscess was detected
     behind the middle of the left sterno-mastoid,
     pressure on which caused discharge of the serum
     and caseous flakes from the sinus on the right
     side of the neck; no retropharyngeal swelling
     could be seen, and there was no enlargement of
     the liver or spleen.   A few weeks later the
     communication, between the abscess and the sinus
     on the opposite side, could no longer be demonstrated,
     but pressure on the abscess caused the patient to
     observe that he felt as though something was being
     discharged into the back of his mouth, and when he
     was turned on to his side and pressure was applied
     externally over the abscess, he was able to spit up
     the contents of the latter, demonstrating the
     existence of a pharyngeal sinus.   The abscess was
     incised and drained, and soon after, on testing the
     urine there was no albuminuria detected, and it never
     recurred during the following two months, during
     which the patient was in St. Luke's Hospital.

Particular interest attaches to this case in the apparent association of albuminuria with ingestion of the discharge from a retropharyngeal abscess. From the time the albuminuria was first noticed the urine was frequently examined, and continued to show the presence of albumen until soon after the abscess was drained on to the skin surface.

The cervical abscess seldom passes backwards between the extensor muscles of the neck to point at the back in the region of the ligamentum nuchae.

The extension of a prevertebral abscess upwards in the neck is well shown by the following case:-

D. H. Aet.19.   This patient was under treatment for cervical caries affecting the 6th. and 7th. vertebrae. She had a large retropharyngeal abscess which was on several occasions aspirated from the side of the neck. She did not improve and died after cerebral symptoms had been present for a fortnight.   No organisms were found in the cerebrospinal fluid and no abnormal cellular content.

Post-Mortem.   The cervical spine was exposed from the dorsal aspect, and the vertebral canal opened by removing the spinous processes and laminae.   The right transverse processes of the 6th. and 7th. cervical vertebrae were considerably destroyed, and in this region the pus entered the vertebral canal by the intervertebral foramen.   The cord and meninges appeared to be normal except that the dura was loosely adherent to the bone in the lower cervical region.   The dorsal aspect of all the vertebral bodies and discs appeared normal.   The prevertebral abscess extended from the 7th. cervical vertebra upwards to the base of the skull.   The left transverse process of the atlas was eroded.

The calvarium was opened and the brain and meninges found apparently normal.   No tubercles were found.   On exposing the base of the brain and skull, a collection of inspissated pus was found extradurally, extending in the basilar groove from the right side of the foramen magnum as far as the posterior clinoid process; about the middle of the basilar groove a small thick adhesion bound the pia-arachnoid over the pons to the dura.

Thoracic.   The characteristic feature of abscesses in
this region, as far down as the 11th. thoracic vertebra,
is the tendency to remain mediastinally, without tracking
away from the spine.   In this position an abscess can
only be detected by means of an X-ray photograph.

It is difficult to understand why the abscess
should remain so long in this position.   Not infrequently,
however, the abscess wanders, being guided by an intercostal
nerve;   following the posterior primary division the abscess
may pass back and appear as a dorsal abscess;   or, the
abscess may track with the anterior primary division and
present with the lateral cutaneous branch in the infra-
axillary region;   or again, the abscess may follow the
guidance of a rib, stripping up its covering fascia and
periosteum, and then become subcutaneous over some part
of the rib.   The action of the abscess in stripping the
periosteum from the rib may be misleading, for, if the
abscess be opened up and explored with a probe, the
contact with bare bone may be looked upon as confirming
a tentative diagnosis of tuberculous rib, and resection
is performed.   That such a mistake was made in the
following case is far from certain, but the history is
suggestive and interesting.

Case No.42. G. C. Aet.36.   At the age of 11, he was
        treated for tuberculosis of the 8th. left rib, an
        abscess over this rib in the back, being incised,
        and the rib scraped.   Otherwise he was always
        active and healthy until joining the Army.   In
        1916 he acquired ayphilis, and received a full

course of treatment; otherwise there were no illnesses until 1919, in which year he was discharged from the Army as fit. For some time before demobilisation, he had been experiencing pain over the sternum on exertion, but he made no complaint until some time after leaving the Army, the pains still continuing; a diagnosis of aortic disease was made for which he received a pension for fifteen months. From 1920 until April 1925 he was troubled off and on with 'indigestion' pains, and at the latter date he underwent an operation for gastric ulcer, at which the appendix was also removed.

In 1920 also he began to notice slight pain in the back - felt on stooping to lift anything, his occupation being that of a coal porter. The pain occasionally caused one or two days off work, and was eased by rest. Stiffness was experienced on rising from bed in the mornings, and jolting induced pain in the spine. This condition of affairs continued on and off, but gradually getting worse, until May 1924 when he was in hospital for eleven weeks with right sided pleural effusion. In August 1924, soon after leaving hospital, he consulted his doctor about his back, and was given oils to rub in, and strapping, but without any improvement. Then in April 1925 he went to hospital, and was X-rayed, but the part X-rayed is not known. Operation was performed for gastric ulcer, and a few days after the operation, the patient noticed a prominence of the spine, but made no complaint. When convalescing from the operation, he experienced very acute pain in the back, when rising after sitting for any length of time, and a week or two later returned to the hospital complaining of his back. He was admitted and labelled 'acute nephritis'; cystoscopy was performed while he was an in-patient, and later as an out-patient he received electrical treatment. During examination on one occasion in the electrical department of the hospital, the kyphosis was observed, the spine X-rayed, and the diagnosis made. He was sent to St. Luke's Hospital in August 1925, and has been recumbent since. On admission, he was found to have two dorsal kyphoses, one at the level of the 4th., and the other at the 11th. thoracic vertebra. There was considerable rigidity, but no abscess detected.

The Wassermann reaction was negative and there was no evidence of aortic disease. Since admission to St. Luke's Hospital, he has complained from time
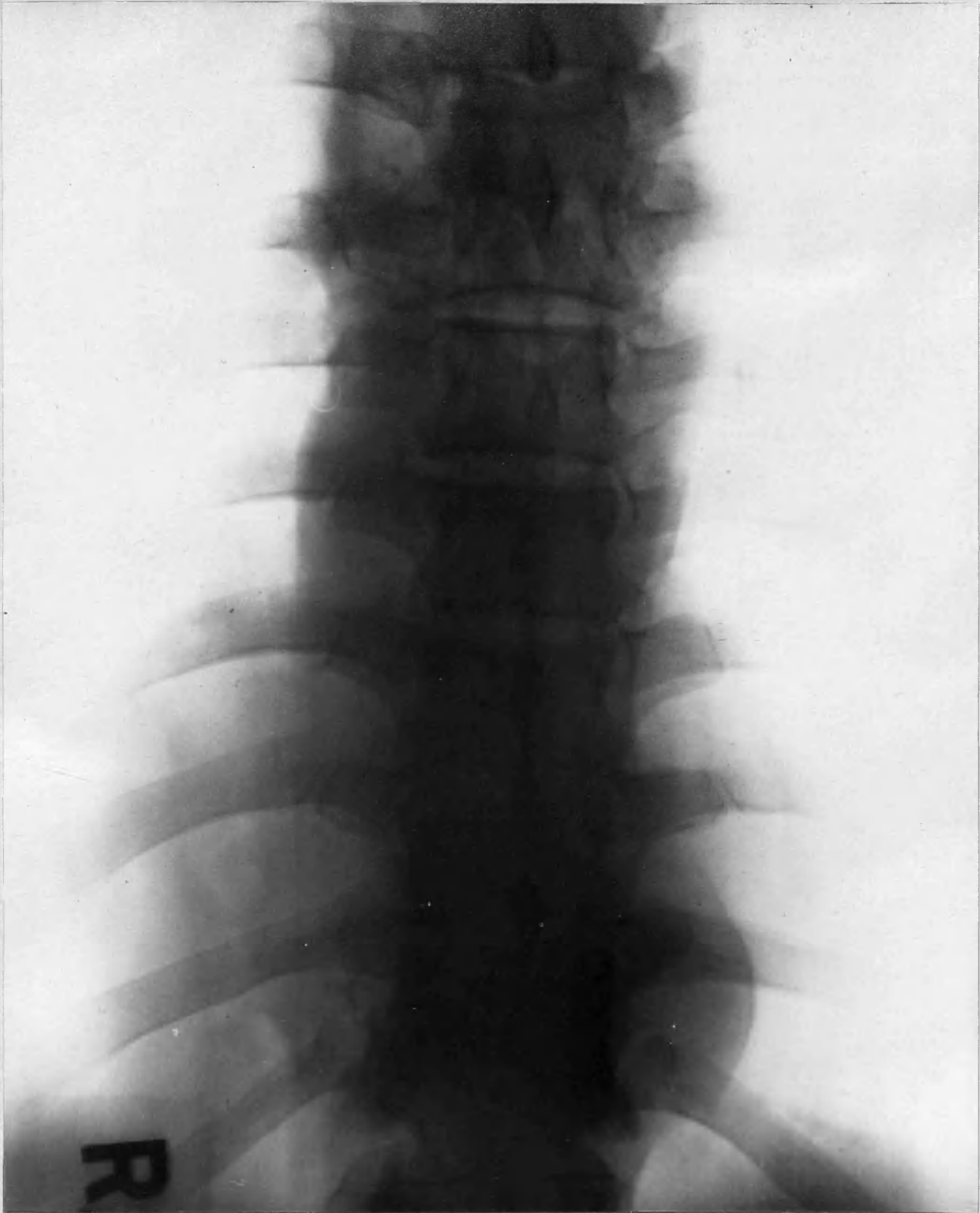
Fig. 3.   Case No.42. G.C. Old standing lesion of the 4th. and
           5th. dorsal vertebrae.   More recent affection of the
           10th. and 11th. vertebrae with abscess.

to time of epigastric pain related to the taking
of food, but not consistently.

The X-ray picture, which is shown in figure 3,
reveals an old standing lesion affecting the 4th.
and 5th. thoracic vertebrae, with some irregular
bone formation but no sign of activity.   There is
also collapse of the 10th. and 11th. thoracic
vertebrae with a mediastinal abscess in this region.
This lower lesion has apparently been responsible
for the symptoms in the back since 1920, but it is
also interesting to speculate, as to how much the
'aortic disease', the 'gastric ulcer' and the
'nephritis' may have been dependent on the spinal
disease.   Also it is possible that the lesion of
the 4th. and 5th. vertebrae was responsible for
the abscess over the 8th. left rib at the age of 11.
Further it is of interest to consider whether the
lower lesion is a direct extension from the upper,
or an entirely independent focus.

It is possible that the tendency of the abscess to

remain prevertebral has some effect in producing the

marked deformities encountered in dorsal lesions.   The

extension of the abscess in the longitudinal direction

is usually greater above the lesion than below, giving

a characteristic appearance in a skiagraph – the shadow

of the abscess extending close to the spine for several

vertebrae above the level of the bony lesion, widening

out opposite the diseased vertebrae, and terminating

more abruptly by joining the vertebral shadow close

below the affected region.   The arrangement of the

abscess in this fashion in the dorsal region has
                                              xxxvi.
been likened by Ménard to a swallow's nest.

As I have already indicated, there is reason to believe

that in the less acute abscesses, the organisms are

influenced by the force of gravity, and are found in

greatest number in the sedimented necrotic material at the lowest part of the abscess. Consequently, in a dorsal prevertebral abscess the organisms are concentrated in the immediate vicinity of the bone lesion, where they continue their activities. When the abscess wanders from the spine, it usually does so from the lowest part - the region of the lesion, and a large number of the organisms are thus removed from the region of the bone, where in consequence the destructive process is proportionately reduced. Thus, in thoracic disease the activity of the bacilli is localised almost entirely to the site of the original focus as long as the abscess retains its prevertebral position. As a result the destruction of the bone in the region of the primary focus is greater, and collapse and deformity are in consequence more pronounced.

This localised concentration of the bacilli, also tends to increase the likelihood of the dorsal surface of the vertebral bodies being invaded, and so leading to the formation of an intraspinal abscess. This may, therefore, be a factor in the comparative frequency with which paraplegia and root pains are observed, in connection with thoracic lesions.

Lumbar. (including the 12th. thoracic vertebra). An abscess connected with disease of these vertebrae is primarily a psoas abscess in the majority of cases, and

its clinical development is either as an iliopsoas abscess, or as a lumbar abscess.

As an iliopsoas abscess, the tendency is for extension beneath the muscle sheath, to become subcutaneous in the groin above Poupart's ligament, or in the region of the anterior superior spine of the ilium.   Less frequently the abscess passes in the psoas sheath below Poupart's ligament, this being preceded by pain and tenderness in the adductor region of the thigh where the abscess subsequently points.

The lumbar abscess leaves the lateral aspect of the psoas, and extends by way of Grynfeldt's space to the deep aspect of the latissimus dorsi muscle;   here it forms a detectable, deep swelling, or it may proceed to become more superficial by tracking downwards to the triangle of Petit.   The relation of the lumbar abscess to Grynfeldt's space is well shown by the fact that an abscess, arising from a lesion below the level of this space, seldom becomes superficial as a lumbar abscess. From the series of 70 cases, there were 15 with abscess, in which the lesion was entirely below the middle of the 3rd. lumbar vertebra;   of these only 3 presented a lumbar abscess, the remainder having ilio-psoas abscesses.   Out of 29 cases, however, with lumbar, or ilio-psoas abscess, in which the lesion was entirely above the middle of the 3rd. lumbar vertebra, as many as 15 showed a lumbar abscess.

When a psoas abscess attains a considerable size,
it is quite commonly accompanied by marked flatulence
which is evidently dependent on the size of the abscess,
for, if the abscess is evacuated by aspiration the
flatulence passes off, to return again as the abscess
fills up.

An iliopsoas abscess may wander peripherally in
other directions than those already indicated; in rare
cases the extension of the abscess has taken place as
far down as below the knee, and so the following case
is interesting, as demonstrating, apparently, the
possibility of an abscess tracking from the spine as
far as the ankle, before being detected.

Case No. 70.   P. C.   Aet.55.   This man was a clerk with
     a good family history as to health.   He himself
     had left-sided pleurisy with effusion in 1921.

          In 1923, after an attack of influenza he began
     to experience stiffness in the back when rising from
     a chair, and a snapping sensation in the spine when
     walking.   In May 1924 he was admitted to hospital
     on account of pain in the left ankle, and was kept
     in bed a few weeks; on being allowed up it was found
     that walking as far as the length of the ward,
     would induce swelling in the ankle.   This was
     treated with Scott's dressing and a swelling
     developed on the outer side of the ankle, was
     aspirated, and later incised.   A few weeks later
     a swelling developed on the inner side of the left
     ankle, and this also was opened up; a third incision
     was made later and the wounds made to communicate
     with each other.   About this time a 'squelching'
     sensation was obtained on pressing in the right
     groin or over both hips.   In January 1925, he left
     hospital, a sinus on the inner side of the ankle
     still discharging a little pus, particularly when
     the patient walked about.   After 2 months the
     sinus dried up but walking still caused pain in the
     ankle.   Then the patient began to feel pain up the

left leg, hip and groin, and later in the spine and
down the right leg. The pain was experienced
mostly in the legs when walking, and in the back
when lying down. After being up in the day, the
legs would be observed to be very much swollen at
night, the swelling subsiding before the next
morning; when swollen the legs were least painful.
At this time he was treated by his panel doctor
for rheumatism. A further symptom was observed
in that when walking the left leg would drag and
turn outwards. In May 1925 he went to hospital
and was examined, when an abscess was detected and
he was admitted, and recumbent until admission to
St. Luke's Hospital in August 1925. At that time
I examined him, and found an abscess in the right
iliac region, and a sinus with a moderate amount
of discharge on the outer side of the left thigh
just below the buttock. There was no spinal
deformity, no pain or tenderness, but a moderate
degree of lumbar rigidity. The left ankle
appeared to be perfectly normal, movements were
full and free, and the scars all sound. The
circumference of the left calf was a quarter inch
greater than that of the right calf. Movements
of the left hip and knee were free and painless.

The pus from the abscess was examined and
tubercle bacilli were found in a direct smear.

The X-rays showed disease of the 4th. and
5th. lumbar vertebrae.

(5)   Deformity.   The true deformity of Pott's disease is

a kyphosis. According to Lovett the earliest deformity

in all cases of spinal caries is a lateral curvature,
                                        xxxvii.
varying in extent in different cases.   This is

not observed to any degree in adults, and, moreover,

slight lateral deviations in an adult would probably be

equally well attributable to postural defect.

The significance of a slight deformity in an adult

is only marked in the presence of other symptoms and

signs pointing to disease of the spine in the deformed

region.   In a child the slightest deviation must have
some pathological cause, but in the adult where occupation
and postural habits have had opportunity of effecting
slight changes, the normal curves of the spine may
appear modified to some extent.

The kyphosis in spinal caries is produced by
collapse of the anterior parts of the vertebral bodies,
the bone and disc, or discs, in the affected region,
having been destroyed.   The spinous processes of the
diseased vertebrae tend to separate, and to become
prominent.   This degree of prominence varies with the
degree of collapse, and when the latter is sufficiently
extensive the prominence of the spinous processes
becomes appreciable by visual inspection.   The smaller
prominences are only detected by palpation.   When the
lumbar region is affected, the deformity tends to be
masked for a considerable time by the erector spinae
muscles, and what to the eye may appear to be a very
mild deformity is found to be a marked angular kyphosis
when palpated.

When, as is most usual, the collapse affects
particularly, two adjacent vertebrae, and the intervening
disc, the kyphosis is acute and angular, but if several
vertebrae are involved, the deformity is more diffuse,
and rounded.

The collapse of the vertebrae is largely due to the

action of the force of gravity, but may also result from muscular contraction, for simple recumbency does not prevent collapse when the disease is progressing; this is due to the reflex muscular contracture induced in the spinal muscles of the region affected.

The degree of deformity shows varying tendencies in the different regions of the spine. In the neck, as a rule, deformity is slight; in the dorsal region it is usually very marked; in the dorsilumbar region it tends to be acutely angular, and in the lumbar region the deformity may be very slight until the disease is far advanced.

(6) Additional symptoms. Under this heading I have included brief references to certain symptoms which were prominent features in some of my cases.

(a) Stiffness of the back. Although rigidity of the spinal muscles is invariably present in active disease of the spine, yet it is not always observed by the patient. This is largely due to the fact that the movements by which stiffness would be observed, are painful, and so it is the pain and not the stiffness which forms the subject of complaint. In a certain proportion of cases, however - particularly muscular individuals - stiffness of the back is a symptom. Of the 70 cases I have investigated, in only 15 was

stiffness a cause for complaint as distinct from pain, in 3 cases being the first symptom. It is probable that a moderate degree of stiffness is the earliest symptom in a much larger number of cases, but it is disregarded, or the subsequent development of pain excludes further reference to the stiffness. None of the 3 cases, in which this symptom formed the earliest complaint, ever had any marked pain.

(b) <u>Deformity other than kyphosis</u>. In suboccipital disease a lateral deviation of the head is frequently observed, being accompanied by rigidity of the sternomastoid muscle of the side to which the head is turned.

The presence of a limp was observed to be a prominent symptom in 6 of my cases, being due either to the presence of a psoas abscess, or the early stages of paraplegia.

(c) <u>Swelling of the leg</u>. This was present in 2 cases as the first sign of spinal disease, in each case being due to the presence of a large ilio-psoas abscess. One of these cases was treated for some time as a case of varicose veins of the leg.

CLINICAL EXAMINATION.

In the examination of a patient in whom spinal
caries is suspected, the principal factors for consideration.
are

(1)   General condition.

(2)   Deformity.

(3)   Tenderness.

(4)   Pain.

(5)   Rigidity.

(6)   Abscess.

(1)   General condition.   Although the effect of spinal
caries, as of any tuberculous condition, is to produce
general ill health, there is very little of importance,
from a diagnostic point of view, to be gained by a
consideration of the patient's general condition.
In acute cases there may be evidence of recent loss of
weight, night sweats, anorexia, etc., but the diagnosis
is indicated by other signs than these.

The temperature and pulse rate are of no
diagnostic value.

(2)   Deformity.   This is the first sign to be investigated
in all cases - by inspection primarily, and then by
palpation.

A visible kyphosis is, of course, practically diagnostic unless it can be accounted for by injury, or postural defect.   In some individuals postural habit induces a marked prominence in the cervico-dorsal region, but in any other region of the spine, gross injury being excluded, a visible kyphosis indicates vertebral disease.

It is for the detection of small degrees of deformity that particular care is required in making an examination of the spine.   For this purpose, the patient should be stripped to the hips, and lying in the prone position. By this means the normal posterior convexities of the spinal column are rendered less evident, and any abnormal prominence is shown up by greater contrast; also by this position the muscles are relaxed as much as possible.   To get the patient flat all pillows should be removed, and the arms should be extended laterally.   With the patient arranged thus, the tips of the spinous processes should be palpated from above downwards, and any deviation from the normal observed.

Slight irregularities should be considered in these cases with the greatest care.   Where they would be looked upon as within the limits of normal variation for most adults, in a patient in whom Pott's disease is suspected they must be carefully examined, each one, in order to ascertain whether a lesion in the region of

the spinous irregularity could account for the symptoms
of the patient.   This is often very difficult to do.
Slight lateral, and anteroposterior displacements of a
single spinous process are not infrequently met with in
individuals free from spinal disease, and particularly
in the dorsilumbar region, which is also the commonest
site for tuberculous affection of the spine in adults.

In the cervical region, the spinous processes are
of very little assistance in the detection of deformity
as they are deeply placed below the ligamentum nuchae.

As a result of examination of the line of the
spinous processes, and by consideration of the patient's
symptoms, a certain part of the spine is indicated as
being the part involved, if any, and this region
requires to be examined further.

(3)   Tenderness.   The value of this symptom in the
diagnosis of Pott's disease in the adult is largely
of a negative character.

Behan considers the tenderness of the spinous
processes in the region of the lesion in Pott's disease
xxxviii.
to be characteristic.   This may be true in
children, but, apart from the rare acute cases, bone
tenderness in spinal caries in the adult is uncommon.
Even in acute cases the bone tenderness is not clearly
demonstrable as it is confused by hyperaesthesia of
the skin over the lesion.

In the routine examination of the spines of patients admitted to St. Luke's Hospital, whether suffering from spinal caries or not, it is not infrequently observed that quite a large number of patients, invariably females, exhibit a general tenderness, or irregularly localised areas of tenderness, over the spine. Such patients may readily mislead the examiner, who is expecting to elicit tenderness over the spinal lesion, into a diagnosis of caries, where none exists. In such patients the sites where tenderness is elicited are seldom constant, and the same symptom is usually demonstrable by ordinary pressure over other subcutaneous bony prominences in the body; the tenderness is apparently produced by a hyper-sensitiveness in the subcutaneous tissues. On the other hand, it is necessary to bear in mind, in dealing with these patients, that spinal disease may be present, although the disease is not the source of the tenderness.

It is necessary in examining for spinal tenderness to avoid excessive pressure; whereas, in the type of patient just described, ordinary pressure over a bony prominence elicits tenderness in the intervening subcutaneous tissues, so in more normal individuals a heavy pressure may be sufficient stimulus to elicit the same subcutaneous tenderness.

A type of superficial tenderness over a spinal lesion

is sometimes encountered in cases where the disease
has resulted in a slight kyphosis.   This prominence
is liable to come into contact with external objects,
and the superjacent skin is subjected to pressures
which normally it does not encounter, such as the
friction of braces, or pressure against the back of a
seat, etc.   In consequence the skin becomes hyper-
sensitive and tender.

Palpation of the front of the cervical vertebrae,
and the site of the lesion if such exists, is not often
possible in the adult, and any tenderness elicited in
attempting to do so, cannot readily be differentiated
from tenderness of the intervening structures.

As a general rule, bone tenderness is not elicited
in spinal caries in the adult.

(4)   Pain.   As pain in the back is the commonest symptom
of spinal disease, if follows that the examination of
a patient for spinal caries is most likely to be related
to a complaint of this pain.   In-patients with this
symptom, however, its description by the patient is of
more importance than its demonstration clinically, the
latter being merely confirmatory of the patient's
complaint.

This may be rapidly carried out, if considered
necessary, by causing the patient to execute movements

such as touching the toes, since the pain is invariably associated with active movements.

It is in the cases in which there is no complaint of pain in the back attributable to muscle fatigue, that the clinical examination for pain is of most importance. In eliciting this symptom, the movements of importance are passive rather than active - passive anteflexion and dorsiflexion of the spine.. As I have already pointed out, the cases in which backache is not a symptom usually show good muscular development, and so the resistance to passive anteflexion would be considerable; therefore it would be very difficult to control, and localise the passive movement with any degree of accuracy, and so passive dorsiflexion becomes the movement of importance in this examination. It is easy to carry out, readily controlled, and can be localised with greater accuracy. The object of passive dorsiflexion of the spine is to induce movement between the affected parts, if such be present, and the more closely this movement can be limited to the vertebrae it is desired to test, the greater is the value of the examination. In children this may be carried out with a certain degree of accuracy, but in adults it is very difficult.

In patients who complain of muscular pain in the back, and in whom this is readily elicited by movement,

the attempt to move the affected vertebrae induces
spasm in the already rigid muscles, and this spasm is
painful and confuses the result of the examination.

It is necessary to remember in carrying out this
test of passive dorsiflexion, that the mobility of the
spine varies normally in this sense in the different
regions of the column.   Too much pressure in inducing
dorsiflexion must be avoided as it is a normal range of
movement which is required, and not abnormal movement as
the latter would be painful of itself apart from disease.

The patient should be placed in the prone position,
the thorax being raised by the support of the patient's
elbows.

The cervical and cervico-dorsal regions are tested
by the examiner fixing the trunk with one hand placed
between the shoulders, and pressing firmly in a ventral
direction, while the other hand presses steadily in
the opposite sense on the patient's forehead.   In some
individuals the upper dorsal vertebrae may be tested in
this way, but it is usually difficult to elicit any
flexion movement in this part of the spine.

From the mid-dorsal region downwards the examination
is carried out with one hand supporting the thorax, and
the other hand pressing firmly downwards over, and just
below, the suspected vertebrae.   As the lumbar region

is examined the supporting hand should be applied to the patient's chest over the lower part of the sternum, so as to localise the moving force more closely to the region being examined.

An alternative method of dorsiflexing the lower part of the spine is by raising the thighs with one hand and arm, the patient's knees being extended, the other hand fixing the trunk just above the region which is being tested.

By these procedures, in cases where the disease is at all active in the vertebrae, pain is induced by movement between the affected parts, and stretching of the inflamed prevertebral tissues, and is referred to the spine; or, it may be felt in the muscles of the back as a result of painful spasm induced reflexly from the diseased region.

The pain is usually of a sharp character causing the patient to resist or exclaim.

A further precaution must be taken in carrying out the examination, so that the pressure applied over the spine should not be concentrated over the spinous processes, but diffused over the whole width of the spine; otherwise there is a liability to induce tenderness by the localised pressure, and this would mask the symptom which is being investigated.   To

avoid this the pressure should be applied uniformly
with the flat of the hand placed transversely to the
long axis of the spine.

Where neuralgic pain is a symptom of spinal disease,
it is not infrequently induced by the passive dorsi-
flexion - pain being felt in the course and distribution
of the nerve fibres involved.   This is in keeping with
the explanation I have already indicated as to the cause
of these pains, the nerves being hyper-irritable.

Pain on jarring of the back may be elicited as a
clinical symptom.   Where the patient gives an accurate
description of the symptom occurring whenever he is
jolted in any way, there is no necessity to attempt to
induce the symptom clinically, unless for some reason
the patient's story is doubted.   The most convenient
way of carrying out the examination with adults is by
thumping the patient's back up and down the spine;   if
the jarring induced causes pain to be felt constantly
in one part of the spine, quite independently of the
region thumped, that part is presumably the seat of the
disease.   Where the pains of muscle fatigue are present,
the pain may be referred to the muscles on account of
the spasm induced in them by the violent stimulation.
However, this somewhat crude method of examining a
patient, in whom spinal caries is suspected, is seldom
necessary, for, if the patient has never experienced

pain in the back on jarring of the spine before coming for examination, he will certainly not show the symptom clinically.

(5)   Rigidity.   This may be of two kinds in connection with spinal caries (a) bony rigidity and (b) muscular rigidity. Bony rigidity is a sign of repair in the diseased area, and does not therefore require further consideration, from the point of view of early diagnosis.

The detection of muscular rigidity, however, in examining a patient for spinal caries, is of the utmost importance.   It is a more constant accompaniment of Pott's disease than is the symptom of pain in the back. Whenever pain is present in the back, and due to spinal disease, rigidity is also present; even in cases in which there is no pain, there is usually rigidity of the muscles of the back.   Some degree of rigidity is probably present in all cases of active caries, but it is not always easy to detect.

It is the result of a reflex action, the stimulus arising in the affected area, and the response taking the form of increased postural tone in the spinal muscles on all sides of the lesion in order to immobilise the site of disease, and protect it from external moving forces.   This muscular action is similar to that which is observed about a diseased hip, where the contracture is best shown in the adductor group of muscles in the

thigh - this contracture tending to immobilise the
joint; in dislocations and fractures also, muscular
rigidity develops soon after the injury, so that before
reduction or setting can be carried out, the local
muscular contracture must be overcome.

In these cases a distinct relationship of cause
and effect appears to exist between pain and muscular
rigidity, and it is frequently asserted that the rigidity
of spinal caries is at first voluntary because of pain,
and later is automatically maintained. This seems,
however, an inadequate explanation, and although
voluntary contracture may take place in addition, the
primary factor in inducing rigidity seems to be an
involuntary reflex action. There are cases in which
it is impossible to obtain a history of pain, or to
elicit pain on examination, and yet rigidity may be
well marked. Again, when a case of spinal caries is
under treatment in the recumbent position, pain soon
goes but rigidity persists, and does so until the
disease is quiescent. It is true that the degree of
rigidity is greater where pain is experienced on
movement, than where there is no pain, and thus
increased rigidity may possibly be due to voluntary
contraction - it is more probably the expression of an
increased reflex response to a stimulus arising in a
region where the disease is relatively more active.

The recent work of the late Professor Hunter on the innervation of striated muscle indicates that the muscular rigidity in these cases is maintained by the 'pale' fibres of the muscles of the back - these fibres being supplied by non-medullated nerves derived from the autonomic system.   The rigidity is due primarily to an increase in postural tone.

The examination of a patient for muscular rigidity, in connection with spinal disease must be carried out with the greatest care in all cases where the existence of disease is in doubt.   The normal mobility of the column must be borne in mind, and the possibility of individual variations from the usual without entering the abnormal.   For example, it would be useless to test for rigidity in the thoracic region by asking the patient to touch his toes, as there is normally very little flexion range in the thoracic region; also it would be wrong to diagnose rigidity of the lumbar spine merely because the patient could not touch his toes without bending his knees, or its absence because he was able to do so; the proportionate lengths of arms, trunk, and legs would have to be taken into consideration.

Muscular rigidity is best detected by palpation, but this must be combined with inspection of the range of active movement, limitation of the normal range being of significance when due allowance is made for the possibility of non-pathological modifying factors.

When movement is attempted beyond the range allowed by
the muscular rigidity, an increase in that rigidity
develops and this is readily detected by palpation.

The separation of the tips of the spinous processes
which normally accompanies anteflexion of the spine, and
their approximation during dorsiflexion, is prevented by
the muscular rigidity, but this sign is very difficult to
detect in adults.

The cervical region is tested with the patient
standing, or sitting, when he is asked to carry out
flexion movements of the neck and head, and then to
turn the head to one side and then the other.   The
latter movements are most important when disease of
the suboccipital region is under consideration, a
limitation of movement on one side, or both sides,
being an early sign;   the flexion movements are more
important where disease below the first two cervical
segments is suspected.   After inspection of the range
of active movement, the movements should be repeated
while the examiner palpates the muscles.   The sterno-
mastoid muscles are particularly liable to be rigid in
suboccipital disease.   The lateral masses of the spinal
muscles are readily palpable, and show early evidence of
rigidity in affections of the cervical vertebrae.

The examination of the dorsal region is not
particularly directed to the movements of flexion, but

to those of rotation.   In palpation of the muscles
during these movements, the displacement of the scapulae
interferes with the examination.   The smaller degrees of
rigidity can only be detected by the presence of a
variation of mobility between the two sides.   The
rotatory movement should be carried out with the patient
sitting on a hard seat, which helps to fix the pelvis
and confine the movements to the thoracic region.

The lumbar and dorsilumbar regions are tested by
the movements of flexion, antero-posterior and lateral.
Lateral flexion in cases of caries, quite often, as with
rotation in the dorsal region, shows a difference in the
range of movement between the two sides.   Palpation of
the spinal muscles in the lower dorsal and lumbar regions
should be made with the flat of the hand rather than the
fingers;   a much more accurate conception of the state of
the muscle is thus obtained.

The most satisfactory method of detecting muscular
rigidity in these lower regions of the spine is carried
out with the patient in the prone position.   Active
dorsiflexion may now be examined by the patient's
rising on his elbows and hollowing the back;   passive
dorsiflexion may then be induced by attempting to
increase the dorsiflexion, pressing the thorax back
still further with one hand, retaining the other in the
small of the back to palpate the muscles.   Ot again, a

convenient method of examining the lumbar muscles is
by raising the thighs with one arm and hand, while the
other hand palpates the lumbar muscles.   With the hips
thus fully extended, passive lateral flexion may be
examined, and circumduction also in the lumbar region,
by carrying the thighs to one side and then the other,
and then by combining these movements with those of
dorsiflexion and extension;   meanwhile the state of the
muscles in the lumbar region is examined by palpation.

The detection of rigidity during passive dorsi-
flexion is an indication of the rigidity of the ante-
flexors of the spine, the strain thrown upon these
muscles being met by an increased rigidity, which also,
reflexly, calls forth increased rigidity in the extensors
of the spine.   Psoas rigidity may also be examined by
hyperextension of the hips - where resistance is greater
on one side than the other, it is presumptive evidence
of the presence of a psoas abscess on that side.

(6)   <u>Abscess.</u>   The existence of an abscess should always be
sought in a suspected case of spinal caries, as its
detection may establish an otherwise doubtful diagnosis.

An abscess may indicate its presence by inducing
neuralgic pains, or a secondarily infected abscess may
be suspected by the character of the temperature chart,
and a dull, throbbing, localised pain.   Otherwise it is
necessary to examine the sites where abscesses are usually

formed, as an abscess may be present without causing
any symptoms.

Where the cervical region is under suspicion the
back of the throat should always be examined; a
visible retropharyngeal abscess causes the posterior
pharyngeal wall to appear unduly close to the observer,
relative to the other parts.   The abscess is frequently
asymmetrical, causing a greater fulness on one side than
the other.

Fluctuation deep to the sterno-mastoid should be
sought, and also in the posterior triangles of the neck.
When an abscess is detected in these regions, it is
often tender, and, except in very old standing cases,
is surrounded by infiltrated tissues which give a
characteristic sensation to the touch, distinguishing
the abscess from other fluctuant swellings liable to
be present in these regions.

In examining for an abscess in connection with a
dorsal lesion the interscapular regions should be
palpated, and over the lower ribs.   Where an abscess
is tracking laterally from the spine, it is impossible
to detect it until it begins to come to the surface,
when a visible swelling will be apparent.

The sites to be particularly examined for abscess
in cases of dorsilumbar and lumbar disease are the regions

over the triangles of Petit, and the spaces of Grynfeldt,

in the back; and the iliac fossae in front.   The

presence of a pseudo-fluctuation in the lumbar muscles

is often suggestive of a deep abscess, but the true

lumbar abscess is found external to the lateral border

of the erector spinae muscle.   In examining the iliac

fossae the two sides must be compared - where there is

considerable resistance to palpation on the part of the

patient, an increased degree of resistance on one side

relative to the other may be an indication of the

presence of an abscess.   Deep palpation should be

carried out on both sides of the middle line near the

umbilicus, an abscess occasionally being detectable

here, before it has tracked far enough from the spine

to be felt in the iliac fossa.   When an abscess has

wandered as far as the groin and is apparent there,

it is usually very difficult to recognise by palpation

its central origin.

RADIOGRAPHIC EXAMINATION.

In doubtful cases it is to the X-ray examination of the spine that one must look for a final decision. It is very questionable whether the disease can be so far advanced as to cause symptoms, and yet not be demonstrable by means of a good skiagram. It is probably here that the difficulty lies - in the obtaining of a satisfactory X-ray picture.

The spine in the adult does not always lend itself readily to the purposes of radiography; the thin patient is, as a rule, a comparatively easy subject to X-ray, but the stout, heavily built person provides a very difficult task.

Even when a good X-ray picture has been obtained, it is often very difficult to make a definite decision as to the presence or absence of bone disease. The earliest evidence consists of localised mottling of the bone shadow. This is usually very difficult to detect, and even when present, corroborative clinical evidence is necessary for the diagnosis to be made with any certainty. In the lumbar region gas in the bowel may cause an unevenness of density in the bone shadow which is at times confusing. To eliminate this factor it may be necessary to massage the abdomen immediately before making the exposure - a practice adopted by several continental radiologists. Alone, or in

combination with this massage, an enema prior to
taking a skiagram of the lumbar and sacral regions, is
of assistance in avoiding external modifications of the
bone shadow.   These are refinements, which, unfortunately,
are seldom necessary in X-raying the spine for caries,
as the disease is usually sufficiently advanced to
produce changes in the contour of the bone, and in the
intervertebral discs.

Particularly in young adults, the earliest sign of
disease is almost invariably a thinning of an intervertebral
disc, because of the tendency for the disease to commence
near an epiphyseal line, and the consequent early
involvement of the adjacent cartilage.   In the X-ray
negative this destruction of the disc results in an
approximation of the shadows cast by the adjacent bony
surfaces, so that the vertical space between them is
less than that between adjacent vertebrae above and
below the lesion.   The estimation of the relative
depths of the intervertebral spaces is not a simple
matter of measurement on the negative.   In the first
place the spaces are not all equal throughout the normal
spine, the cervical and lumbar spaces being greater than
the dorsal - these variations have to be taken into
consideration.   More important, however, and more
difficult, where a slight difference is under suspicion,
is the estimation of the variations to be allowed for,
by reason of the relative positions of the patient and

Fig. 4.   Case No.13.   P.S.   Disease of the 12th. dorsal and 1st.
          lumbar vertebrae and intervening disc.

the X-ray tube.   As the X-rays are divergent it is
clear that, if the tube is centred so that a ray
perpendicular to the film passes through an intervertebral
space equidistant from both adjacent bones, the spine
being assumed parallel to the film, then the rays passing
through the spaces above and below will not be
perpendicular to the film, and so the shadows of the
adjacent vertebrae will tend to overlap, diminishing
the space between.

Accompanying a narrowing of the intervertebral
space where such is due to disease, there is usually
observed in a good negative some irregularity of the
outline of the bone shadow either above, or below, the
space, and this irregularity is the most definite
evidence of the presence of disease which can be
required.   Figure 4 shows a print from an X-ray
negative, from a patient with disease of the 12th.
dorsal and 1st. lumbar vertebrae and the disc between
them.   The changes are not very extensive according to
the photo, yet in this patient the symptoms dated back
for 3 years.   The upper part of the 1st. lumbar
vertebra has apparently been most affected, but there
is mottling of the shadow of the lower part of the 12th.
dorsal vertebra;   the intervertebral disc has obviously
been extensively destroyed.

In Figure 5 the bony destruction is well marked in

Fig. 5.   Case No.34.   M.H.   Disease of the 2nd. and 3rd. lumbar
vertebrae and intervening disc.

the lower part of the 2nd. lumbar vertebra, but the disc
is apparently not so extensively affected as in the
lesion in Figure 4, and the upper part of the 3rd. lumbar
vertebra shows only slight change. The patient, of
whose spine this is a picture, had a history of onset
of symptoms roughly 5 years prior to the time when the
X-ray photograph was taken, and had an inguinal sinus
discharging from an ilio-psoas abscess.

Figure 6 shows a double lesion of the lumbar spine
in which there is apparently no great destruction of
bone, but the discs have been considerably reduced.

A consideration of the fact that the rays are
propagated in straight lines, and throw the shadow of
three-dimensional structures on to a plane surface,
clearly demonstrates the possibility of slight bone
lesions escaping detection in certain positions of the
affected vertebrae relative to the rays. Consequently
it is often necessary to make several exposures with
the patient in different positions relative to the tube
before a definite decision can be made. Stereoscopic
photographs of the spine are also of value.

The antero-posterior skiagram of the cervical region
is not a matter of special difficulty except in the
upper part where the lower jaw interferes with the
result. A clear view of the suboccipital region,

Fig. 6.   Case No.48.   J.H.   Double lesion.   Disease of the 12th.
dorsal and 1st. lumbar vertebrae and disc;   disease of
the 3rd. and 4th. lumbar vertebrae and disc.
Intervening portion of spine apparently healthy.

however, can be obtained by making the exposure with
the mouth held wide open.

In the thoracic and lumbar regions no special
difficulties have to be considered, but it is often very
difficult to obtain clear definition of the lumbo-
sacral articulation owing to the abrupt transition at
this point from the lumbar to the sacral curve.   To
obviate this,the method advocated by Capelle, I have
found effective.   xxxix.   This is, briefly, to place the
patient on the table in the prone position with the X-
ray tube above him;   the lumbar curve is arched by
supporting the thorax, and the tube is placed with the
anticathode vertically above the 2nd. lumbar spinous
process, and about 22" from the film which is placed
beneath the patient.   The tube is tilted so that the
central rays are directed approximately through the
lumbo-sacral articulation.   The curve of the lumbar
region with the patient in this position, is such that
the rays pass through the intervertebral spaces roughly
parallel to the adjacent vertebral surfaces.   By this
means a clear picture of the lumbar interspaces, and in
particular the lumbo-sacral interspace, is obtained.

The skiagram taken with the patient in the lateral
position is of great importance, particularly when
considered in conjunction with the antero-posterior
exposure.   Where the lesion, as is so often the case,

affects the anterior aspect alone of the vertebral body,

the lateral view will reveal the disease to an extent which

is impossible with an antero-posterior view.   Unfortunately,

however, in these cases in which the lateral view would be

of such diagnostic importance, the development of symptoms

is relatively later, than in the cases in which the bone

adjacent to a disc, and the disc itself, are affected.

In these cases also the lateral skiagram, if a good one,

will show the extent of the disease - the narrowing of

the disc anteriorly, and the irregularity of bony

outline;   and it will show them as clearly, if not more

so, than the antero-posterior skiagram, because there is

not the intervention of the shadows of the spinous, and

more particularly the articular processes, to confuse the

outlines.   But on the other hand the difficulties in

obtaining a clearly defined outline, with detail, by

the lateral skiagram, are much greater than by the

antero-posterior - this refers of course to adults,

and also to the lumbar and dorsal regions of the spine.

The lateral picture of the cervical region is comparatively

easy to obtain.   In the thoracic region the rib shadows

tend to obscure the shadow of the spine, and in the

lower lumbar region the ilia constitute an almost

impassable barrier to the obtaining of clear definition

in the vertebral outlines.   The lateral skiagram is of

greatest value, from a diagnostic standpoint in early

cases, in conjunction with the antero-posterior

skiagram, because the small anterior lesion which may not show in the latter picture, is shown up in a good lateral one. Here again, one lateral exposure may not be sufficient in order to relieve a spine from the suspicion of disease.

Where there has been a moderate degree of collapse of the vertebrae due to disease, the bony shadows in the antero-posterior view tend to overlap, so that the discs which may be normal appear to be obliterated. In these cases the lateral view shows up the true extent of the disease.

The X-rays are also of the greatest value in estimating the progress of the disease, or its healing, but this does not come within the scope of the present subject.

The detection of an abscess by means of the X-rays is often possible, particularly when it is prevertebral in position. When the abscess has tracked away from the spine, for example, to become a psoas abscess, it may or may not be shown. In the dorsal region, a prevertebral abscess usually shows up well, and this may be the only method by which its presence may be detected, when this region of the spine is affected. The shadow cast by the mediastinal abscess has, characteristically, a fusiform outline, or the "swallow's nest" appearance.

Jones and Lovett consider that the fusiform shadow may be due to a perivertebral thickening, rather than an abscess;   such a distinction seems unnecessarily fine in view of the fact that an abscess is always present in cases of spinal caries, and where the abscess is present the surrounding tissues - perivertebral - are thickened, so that the shadow, whether due to abscess or perivertebral thickening, indicates the presence of an abscess.

In some individuals in whom the spine itself is normal,a paravertebral shadow is shown in the skiagram of the thoracic spine - mildly fusiform sometimes, but more often with the lateral margins of the shadow more or less vertical, and extending alongside several consecutive vertebrae.   The explanation of this shadow is not known.

An abscess in connection with cervical disease is also quite prominently shown in the skiagram, as a rule, and less commonly a psoas abscess may be indicated.

C O M P L I C A T I O N S.

The complication of abscess I have already dealt with as a symptom of spinal caries. Brief references are necessary to the other principal complications - sinus formation and paraplegia - as they occasionally appear as the indications on which a diagnosis of spinal caries is made.

Sinus formation. This is a most serious complication owing to the dangers attendant on secondary infection which may lead to amyloid disease.

It is sometimes the persistence of a sinus, or the breaking down of the incision soar, after an abscess has been opened and sutured, which first leads the presence of tuberculous disease to be suspected in cases of Pott's disease. This has not infrequently occurred in cases which have been sent to St. Luke's Hospital for treatment. As the presence of an abscess may be the earliest sign of spinal disease, it is obviously important that its nature and origin should be recognised before the abscess is opened.

Paraplegia. This complication, varying from mild spasticity to rigidity of the legs in flexion with double incontinence, was present at some stage in 10 of my series of 70 cases. In 5 of these cases, paralysis of the legs was present before a diagnosis of spinal

caries was made, and in 1 case paralysis was the first
cause of complaint.

The commonest cause of spastic paraplegia is spinal
caries.

The onset of paraplegia due to spinal caries is
usually gradual, the earliest indication being a feeling
of weakness, and a tendency to drag, shown by one leg -
later present in both legs.   This is due to the loss of
power which is greater in the flexors, than in the
extensors, of the legs.   The presence of a psoas
abscess is also a cause of dragging of the leg on the
affected side, but this is distinguished from the
paraplegic symptom by the absence of spasticity, which
develops early in the paraplegic.   Spasticity may not
be apparent in the gait to begin with, but is indicated
by exaggeration of the knee-jerks, resulting from the
increased muscle tone which mainly affects the extensors
of the legs.

Should the condition remain undiagnosed, and even
in cases under treatment, progressive weakness of the legs
ensues with relatively increased extensor tone, until in
the untreated case, the patient may be unable to walk
and is confined to bed.   In this state of paraplegia
in extension the patient lies with the legs fully
extended, and is unable to raise them from the bed.

Some resistance to passive flexion is offered by the
extensors and 'clasp-knife rigidity' may be observed.
The knee jerks are greatly exaggerated, and the plantar
reflex response is extensor.

Sensory disturbances may or may not be present.
The earliest changes occur in the feet, and extend
higher up the legs as the 'compression' of the cord
increases.

Visceral symptoms are usually referable to the
bladder before the rectum, as the earliest sign is a
difficulty in initiating the urinary flow, which excites
more distress than the accompanying tendency to
constipation.

Should the condition not improve, flexion
contracture of the legs develops, and bladder and
rectal incontinence.

As I have already indicated paraplegia in spinal
caries is usually due to interference with the circulation
of the cord, rather than actual compression.

DIFFERENTIAL DIAGNOSIS.

I do not propose to enter into a detailed reference
to all the possible conditions with which spinal caries
is liable to be confused, but to consider on general
lines the more common, and more likely causes of
confusion in diagnosis.

The symptom of pain is the commonest, the earliest,
and at the same time, unfortunately, the least characteristic
of the evidences of spinal caries.   It is essential in
the first place to obtain a clear and detailed account of
his pain from the patient, remembering that the pains of
spinal caries are of two main types.

(1). Pain in the back - usually in the lumbar
       muscles - due to muscle fatigue.

(2)   Neuralgic pains.

In considering the patient's symptoms from this
standpoint, the etiology of these pains, which I have
referred to in some detail, should be borne in mind.

(1).   In general the chief causes of pain in the back
are

(a)   Trauma.

(b)   Affections of abdominal viscera.

(c)   Infective conditions of the muscles.

(d)   Infective conditions of the spine.

(e)   Abnormal modifications of static equilibrium.

(f)   Constitutional affections.

(a) Tranma. In these cases there is, of course, a history of recent injury - a similar history may exist with spinal caries. Injury, however, followed by persistent pain, is also accompanied by tenderness localised to the injured structure, whether torn muscles, ligament or bony process. Pain is associated with active movement, but passive dorsiflexion is seldom painful, and in many cases relieves the pain.

Dislocations of the vertebrae are detected by the presence of deformity - often very slight. Muscular rigidity may also be present making the diagnosis from spinal caries very difficult.

Within limits, a history of injury preceding closely the pain, of which complaint is made, must cause the injury to be considered the origin of the pain until a reasonable time has been allowed for the effects of the injury to pass off.

Where there is any doubt X-ray examination should be made.

(b) Affections of abdominal viscera. The pain in the back in these cases is referred pain, and is usually accompanied by some other symptom more characteristic of the viscus affected. Uterine disease, perinephric abscess, prostatic disease - these are quite commonly associated with backache, but the periodicity noted in

the backache of spinal caries is not found in these
referred pains – a more or less continuous ache being
present with, however, this feature in common with the
pain of caries – the pain is often relieved by rest in
the recumbent position.

(c)   Infective conditions of the muscles.   Under this
caption are included lumbago, myositis, muscular
rheumatism, etc., and it is with names such as these
that spinal caries is most often labelled in the early
stages.

The most distinctive feature of this group is the
tenderness of the muscles – this being absent in caries.

(d), (e), (f).   The character of the pain in the
conditions of these three groups may be very similar,
in nearly all cases being due to fatigue in the postural
muscles of the back.

(d)   Infective conditions of the spine.   Of this group,
spinal caries itself is the commonest member.   Sacro-
iliac disease may also be included here and its
differentiation from spinal caries is often very
difficult.   Usually however it may be distinguished by
tenderness over the affected joint, and pain felt in this
region on torsion movements being applied to the pelvis.

Spondylitis deformans, 'typhoid spine', traumatic

spondylitis - these are all liable to be causative of
the symptom of pain in the back.   'Typhoid spine' is
associated with convalescence from typhoid, but the
only real distinction of the other conditions is made
by the X-rays.   How much traumatic spondylitis is
dependant on the initial injury, and how much on some
infective process is difficult to determine, and this
somewhat obscure condition can rarely be diagnosed
clinically.   The characteristic X-ray appearances
of the spine in spondylitis deformans are lipping of
the margins of the vertebrae in the region of the
cartilages, and ossification of the intervertebral
ligaments, the latter predominating in the rheumatoid
type, and the former in the osteoarthritic type.

(e)   Abnormal modifications of static equilibrium.   Perhaps
the commonest of these in the adult is visceroptosis.
This, however, is very frequently present without
causing any symptoms at all, and should not therefore,
by its presence, exclude the possibility of spinal caries.
The conditions in group (d) are for the most part,
also, causes of modification of static equilibrium.
Spondylolisthesis, adolescent scoliosis, flatfoot and
the so-called static deformities are all liable to
cause pain in the back.

In all these a definite diagnosis is difficult, as
the onset is vague, and pain is not an essential

accompaniment of any one of the conditions.   Consequently
the diagnosis comes to be one of elimination, and in this
process it is essential that the spine should be examined.
The examination should be carried out in the way I have
described, and failing the presence of a deformity,
rigidity is the sign of most importance in making a
diagnosis of spinal caries.   Where doubt exists as to
the absçence of spinal caries, a skiagram should be
taken.

(f)   Constitutional affections.   These include acute
infections, neurasthenia, anaemia, etc.

Here again the cause of the pain is fatigue of the
spinal muscles, due to a relative insufficiency of
postural tone.   The anti-gravity muscles of the back
are constantly active, so that any debilitating cause
is liable to give rise, in time, to fatigue of these
muscles.

In neurasthenia there is in addition a tendency
to exhaustion of the muscles through over-stimulation,
the sympathetic nerves being hyper-irritable.

Hysteria is another condition which is liable to
be marked by pain in the back.

The origin of the pain in the anti-gravity muscles
in all these conditions makes it very difficult to
distinguish the pain of spinal caries, yet in the latter

there is one factor which tends to give a distinctive character to this symptom, and that is the muscular rigidity.   Because of this, the association of pain with movements is much more constant in spinal caries than in any of the other conditions, on account of the resistance to movement by the rigid muscles.

(2). The neuralgic pains associated with spinal caries may exist for a long time, if they are the first symptom, without any suspicion being aroused as to their origin.

Their neuralgic character should lead to a consideration of all the possible causes of irritation of the nerve affected;   spinal caries is not the most common cause of such pains in many cases, and it is only natural and right that the most common causes should be excluded first.   These are not always easy to exclude and so there is perhaps a tendency to go no further in seeking a cause for the pain, and so the spinal origin is missed.

The feature which should always arouse the necessity for excluding the spine as a causative agent, is the association of the pains with movements of the trunk; this association is invariably observed in the earlier stages.

Tenderness in the course of the nerve to which the neuralgia is referred, is not, as a rule, present in spinal caries.

As examples of common errors in diagnosis of these
neuralgic pains may be mentioned pleurisy when the
dorsal region of the spine is affected, and sciatica
when there is disease of the lower lumbar region; sciatica,
as far as it goes, may be a correct diagnosis in many
cases but the cause should also be indentified.   Hip
disease is also liable to be the diagnosis when the pain
is referred to the buttock and behind the trochanter;
in these cases there is usually a psoas abscess present
which may cause some limitation of movement at the hip,
but this limitation is not as a rule attended by muscular
spasm.   When active hip disease is present in conjunction
with spinal caries, the symptoms of the former mask
almost entirely the symptoms of the latter.

Symmetrical, bilateral, neuralgic pains should
always suggest a central origin, and thus lead to an
examination of the spine, and in the presence of these
symptoms a deformity is usually found.   Other causes of
bilateral root pains are carcinoma of the vertebrae,
and tumours and other affections of the cord and meninges;;
the latter conditions are characterised by motor and
sensory disturbances before pain becomes a symptom, and
moreover the root pains are not usually confined to one
segment, as they invariably are with caries.   Bilateral
root pains together with a history, or the presence, of
carcinoma in some part of the body other than the spine,
is almost diagnostic of secondary carcinomatous disease

of the vertebrae as the source of the pains.

An abscess is quite often one of the earliest signs
of Pott's disease and I have referred to the sites in
which these abscesses are usually found.

A retropharyngeal abscess is most commonly the result
of spinal caries, but the possibility of its origin in
tuberculous, or other chronic , lymphadenitis affecting
the retropharyngeal glands, must be borne in mind.
Here as with fluctuant swellings in other parts of the
neck, the rigidity of the cervical muscles is the
deciding feature.

I have already referred to the liability for a
cold abscess over the thorax to be attributed to
tuberculosis of a rib, even when arising in the spine.
Spinal tuberculosis is more common than tuberculosis of
the rib, and so the spine should first be examined.
Even in the absence of clinical signs in the spine
a diagnosis of tuberculous rib should not be made without
skiagrams of both spine and rib.   A softened gumma, and
less commonly tuberculous empyema, should also be
considered as possible origins.

The detection of an iliopsoas abscess is not
unattended with difficulties.   A loaded colon may
simulate a left sided psoas abscess;   the psoas

muscle itself may give a sensation difficult to distinguish from fluctuation just above the brim of the pelvis – this, however, is symmetrical.

A visible lumbar, or ilio-psoas abscess has not infrequently been mistaken for a hernia. There were 4 such cases in my series of 70, one being considered a case of lumbar hernia, and the other 3 as cases of inguinal hernia; in two of these patients a truss was ordered and worn for some time over the abscess.

In dealing with the question of differential diagnosis, I have avoided a detailed consideration, in order to emphasise the necessity for clinical examination of the spine, whenever any symptom is present which might possibly arise in the spine, and which cannot be definitely attributed to some other cause. The conditions with which spinal caries is liable to be confused, are for the most part lacking in clearly defined clinical characteristics, so that it is easier to exclude spinal caries with its more or less definite signs of deformity and rigidity, before considering the other conditions which may cause similar symptoms.

The more frequent examination of the stripped back in adults complaining of the symptoms I have outlined, would result in a much greater percentage of cases coming

for treatment at a relatively early stage in the
disease.   Further, when an examination of the back
does not definitely negative the possibility of spinal
caries being present, a radiographic examination should
always be made.

     Wherever tuberculous disease is a probable
diagnosis, the possibility of syphilis as the cause
should be remembered.   Syphilis of the spine is rare,
and there are very few cases recorded of incontrovertibly
syphilitic spines.   In this connection the following
case is of interest;   the onset and course of the disease
are not suggestive of tuberculous disease, nor are the
X-ray appearances of the spine, but the numerous sinuses
give a clinical appearance resembling tuberculosis.   The
Wassermann reaction, however, is strongly positive.

C. P.   Aet.54.   This man's occupation was that of a
         gardener.   In 1917 he had an attack of acute pain
         down the middle of the left thigh and leg, of
         sudden onset.   He was laid up for 5 weeks, and
         treated as a case of sciatica by means of blisters;
         he was afterwards as fit as ever and free from pain.

              In December 1923, pain down the left leg, and
         all over the body, came on suddenly one day while he
         was at work;   he walked home with difficulty and
         being worse at night called in his doctor, who
         performed a lumbar puncture, after which the
         patient's pain was not so severe.   He was sent
         into hospital as a case of cerebro-spinal
         meningitis, and kept under observation for nine
         weeks;   during this period he had no pain but
         there was stiffness in the neck limiting flexion
         movements.   Ever since, the left leg has tended
         to drag a little when walking.

A day or two after his discharge from hospital,
he noticed a small lump in the R. lumbar region
which was painful when he lay on it; after about
ten days, the swelling was incised and a week later
a swelling appeared in the left lumbar region, and
this was painless.   The swelling was incised, but
whereas the R. lumbar wound healed up quickly, the
other did not.   Soon afterwards, there was pain in
the upper part of the left thigh posteriorly, and
a third abscess pointed.

In July 1924 he was admitted to hospital, the
left lumbar sinus was opened up, and the thigh
abscess incised.   After eleven weeks he was
discharged, but did no work as he felt very weak.
Following exercise the left leg would become hot
and swollen, subsiding with rest.   He was sent
to a Convalescent Home for six weeks, and soon
after, while at home and attending the hospital
for dressings, his sinuses all healed up.
Immediately afterwards, however, a swelling appeared
in the left inguinal region, preceded by pain.
He was again admitted to hospital in February 1925,
the abscess was incised and has been discharging
since.   He left the hospital in May and in July
was admitted to St. Luke's Hospital.   Just before
going to Lowestoft he developed a swelling over
the left buttock.

On admission to St. Luke's Hospital there was
no spinal deformity detected, no pain or tenderness,
but lumbar mobility was greatly restricted; rigidity
of the muscles however was not very evident.   The
knee jerks and plantar reflexes were normal;   there
were no urinary symptoms.

The left hip movements were also restricted,
there being possible only 75° flexion, 15°
adduction, 20° abduction and practically no
rotation.   There was no clinical evidence of
pubic or sacro-iliac disease, and no other evidence
of hip disease.   There was a recently healed sinus
below the left buttock, and two discharging sinuses
- one in the left lumbar region, and the other in
the left groin.

The X-ray appearance of the spine is shown in
Figure 7.   There is no evidence here of a primary
focus of disease; the secondary infection might
account for the irregular bony formation at the
sides of the vertebrae, and for the bridging between
successive bones, but the lipping of the vertebrae
is more suggestive of osteo-arthritic changes.

Fig. 7.   C. P.   Diffuse osteophytic outgrowths; and lipping of
vertebrae of osteo-arthritic type.   Syphilis and
secondary infection present.

The Wassermann reaction being strongly positive,
anti-syphilitic treatment was instituted, but there
has been no apparent response after four months,
and his condition remains much the same, with the
spine fairly rigid as a whole, and with three
discharging sinuses.   There has been no change
in the X-ray appearances as a result of treatment.

S U M M A R Y.

I have attempted throughout this work to consider
the symptoms and signs of Pott's disease, in the adult,
with reference to its early diagnosis.   The length of
time which elapses between the onset of symptoms and
the diagnosis, especially in cases under supervision -
in my series the average time was over two years -
indicates a very unsatisfactory state of affairs.   I
have dealt in some detail with the production of the
symptom of pain, as pain is, in the majority of
patients, the first cause of complaint.   The
character of the pain in spinal caries, and its
situation, do not definitely distinguish the disease
from other causes of pain in the back;   but they are
at least suggestive of Pott's disease and this should
always be excluded before pain is attributed to some
other cause.   This refers more particularly to the
pain situated in the anti-gravity muscles of the back.
In order that an early diagnosis may be made in cases
of spinal caries in the adult, it is essential that
signs and symptoms such as I have described, and
pointing to the possibility of spinal disease, should
always lead to an examination of the stripped back;
and it is also necessary that the examiner should
realise that, when tuberculous spinal caries is present
in an adult, the spine itself is seldom painful.
Should any doubt exist after the clinical examination,

resort should be had to radiographic examination.

The following conclusions may be drawn from the investigations I have made:-

1.   Tuberculous spinal caries in the adult tends especially to affect the vertebrae from the 11th. thoracic to the 4th. lumbar.

2.   Trauma is seldom present as a predisposing or contributory cause.

3.   Pain, felt in the muscles of the back, is the most common initial symptom.   It is less likely to be a prominent feature of the disease in muscular subjects, engaged in heavy work, than in those who lead sedentary lives.

4.   The pain is the expression of inadequate postural tone in the anti-gravity muscles of the back.   This tone, though inadequate, is relatively greater than the normal, and so produces rigidity;   in consequence the pain is more constantly associated with the movements throwing a strain on the rigid muscles, than is the pain due to inadequacy of postural tone, arising from other causes.

5.   The production of so-called'root pains', associated with spinal caries, is not always confined to the nerve roots themselves.   In many cases they are the result of involvement of a peripheral nerve by a psoas abscess.

Hyper-irritability of the nerve roots resulting from
interference with their blood supply by an abscess,
is the essential factor in the production of true
root pains.

6.   Pain in the back on jarring of the spine is not
necessarily diagnostic of spinal caries.

7.   The prevertebral abscess, in connection with disease
of the thoracic region, does not tend to track away from
the spine to the same extent as in other regions of the
spine, and this may account for the greater frequency
with which paraplegia and root pains are observed when
the thoracic vertebrae are diseased; and also for the
more marked deformities encountered in this part of the
spine.

8.   Stiffness of the back is not a frequent cause of
complaint in patients suffering from Pott's disease.

9.   Deformity is, in the majority of cases, present in
some degree, usually very slight but detectable, at the
time of onset of symptoms.

10.   Muscular rigidity in the region of the spinal
lesion is the most constant clinical sign of Pott's
disease, and is always present so long as the disease
is active.

11.   Tenderness of the spine is uncommon in adult cases

of spinal caries.

12.   A patient, complaining of symptoms attributable
to spinal disease, should always be examined with the
back stripped, particular attention being paid to the
signs of deformity and rigidity; and finally, X-ray
examination of the spine should be made the deciding
factor in cases of doubt.   In this way, **only, will it**
be possible to obtain cases for treatment at **an early**
stage of the disease.

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