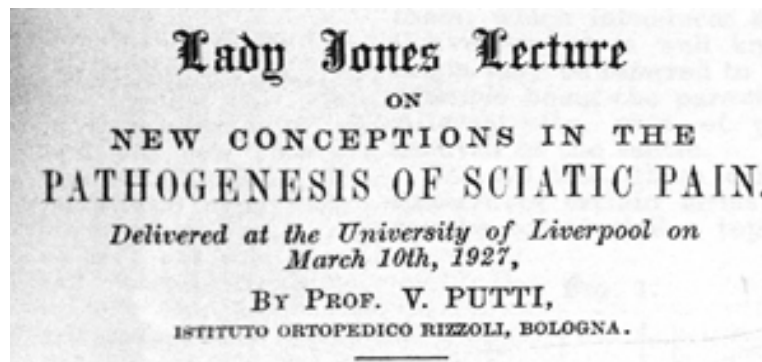


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NEW CONCEPTIONS IN THE PATHOGENESIS OF SCIATIC PAIN

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In this lecture I want to unfold a subject which has attracted my attention for many years and which I consider of general interest. What practitioner, indeed, is not interested in the discovery of the causes and cure of a disease, whose predominant symptom is pain?

There is a Latin saying: *Divinum est sedare dolorem*. If pain implies physical suffering, this divine labour is entirely entrusted to the wisdom and humanity of the doctor. Is not our highest, noblest, and most difficult task the endeavour, within our limitations, to soothe, diminish, and occasionally to abolish physical pain? For mental pain, man is his own best physician. One of the great tragic poets, Alfred de Musset, has said: "*L'homme est un apprenti, et la douleur est son maître*." But for all that, will-power, moral training, self-control none of them suffice to banish physical pain. Who but the doctor can hope to attain success, and what practitioner is indifferent to the great warfare against pain?

For the past four years and more, I have been studying the subject of the causation of sciatic pain. I have had the opportunity of studying this symptom with vast clinical material, with dissections, and, above all, with a very rich collection of radiographs. While I was in the midst of my investigations, publications by French and American authors appeared which

threw much light on the subject, and which suggested to me new points for observation. It has, therefore, seemed to me useful to communicate to you now my results up to date.

Amongst painful diseases, sciatica occupies a foremost place by reason of its prevalence, its production by a great variety of conditions, the great disablement it may produce, and its tendency to relapse; all of which have long ago led to its recognition as one of the great scourges of humanity. It has been known as long as medicine has been studied, but it has only been recognised as a clinical entity since an Italian physician, Domenico Cotunio, gave a complete description of it, towards the middle of the eighteenth century. The ancients named it ischias and "*De Ischiade Nervosa*" is the title of the book in which Domenico Cotunio gave its clinical picture. Hence it was long called Cotunio's disease. The name of this great Neapolitan practitioner should not be unfamiliar to you, for it is to him we owe the first accurate description of the fluid contained in the meninges, the cerebro-spinal fluid, or Cotunio's fluid. Cotunio was not only the first to isolate sciatica as a clinical entity, but he also made a distinction between anterior and posterior sciatica, a differentiation which is based on good anatomical grounds and still has considerable clinical value.

Since the time of Cotunio, chiefly through the efforts of neurologists, the symptomatology of sciatica has been increasingly well defined, and today we may say that we have the complete clinical pictures, and the differential diagnosis is easy. The same cannot be said of the pathology, which remains obscure in many respects. Orthopaedic surgeons began to occupy themselves with subject of sciatica when it was found that in many cases it was associated with deformities, and often took origin from malformations and diseases the skeleton. Charcot was one of the first to draw attention to the frequent association of sciatica with vertebral deformity, and Brissot first coined the term "sciatic scoliosis," that is to say lateral curvature due to sciatica.

I already denoted sciatica a symptom, and such, I think, it should be considered, at any rate from the clinical standpoint. It is only when the pain is due to direct involvement of the nerve by the pathological process that sciatica can be considered a primary disease, and this is rare. In the majority of cases sciatica is only a manifestation of diseases external to the nerve, or at any rate the nerve is only involved as part of a constitutional disease. It is well known that diabetes, syphilis, alcoholism, lead poisoning, and other general toxæmias may cause sciatica by inducing inflammatory and degenerative changes in the nerve. These are true forms of neuritis and can be classed as alcoholic; diabetic, syphilitic, and so on, from the disease primarily responsible. In other cases, the cause is local, and pain is due to compression or irritation of the nerve-trunk at some point or other in its course. Such causes are: tuberculosis, syphilis, vertebral tumours, pelvic and other tumours, as well as fractures. Such secondary sciatica may have an infinite variety of causes, but these have no special interest for us at the moment.

The most common type of sciatica is not of these. It appears and progresses without obvious cause, or, to use the Latin expression, *sine materia*. It is usually called "essential" or "idiopathic sciatica," two rather meaningless words, which were created to indicate our ignorance of the origin and nature of the morbid process. Essential sciatica is sometimes called rheumatic sciatica, because it frequently develops after chills and in individuals of rheumatic or gouty constitution. It thus forms part of the neuro-arthritic syndrome, to which so much attention was formerly paid.

NATURE AND PATHOLOGY OF SCIATIC NEURALGIAS

But, as a matter of fact, the true nature and mechanism of production of these neuralgias remained in complete obscurity until a few years ago- witness the innumerable therapeutic measures which had been evolved for their treatment. The cause being unknown, attempts were made to treat the results. But it is obvious that symptomatic treatment inevitably yields only unreliable, or incomplete, results, and it may be said that up to the present day there has been no rational, radical cure of idiopathic sciatica.

As the researches of the past few years have thrown much light on the subject, let us consider for a moment our points of departure and of attainment.

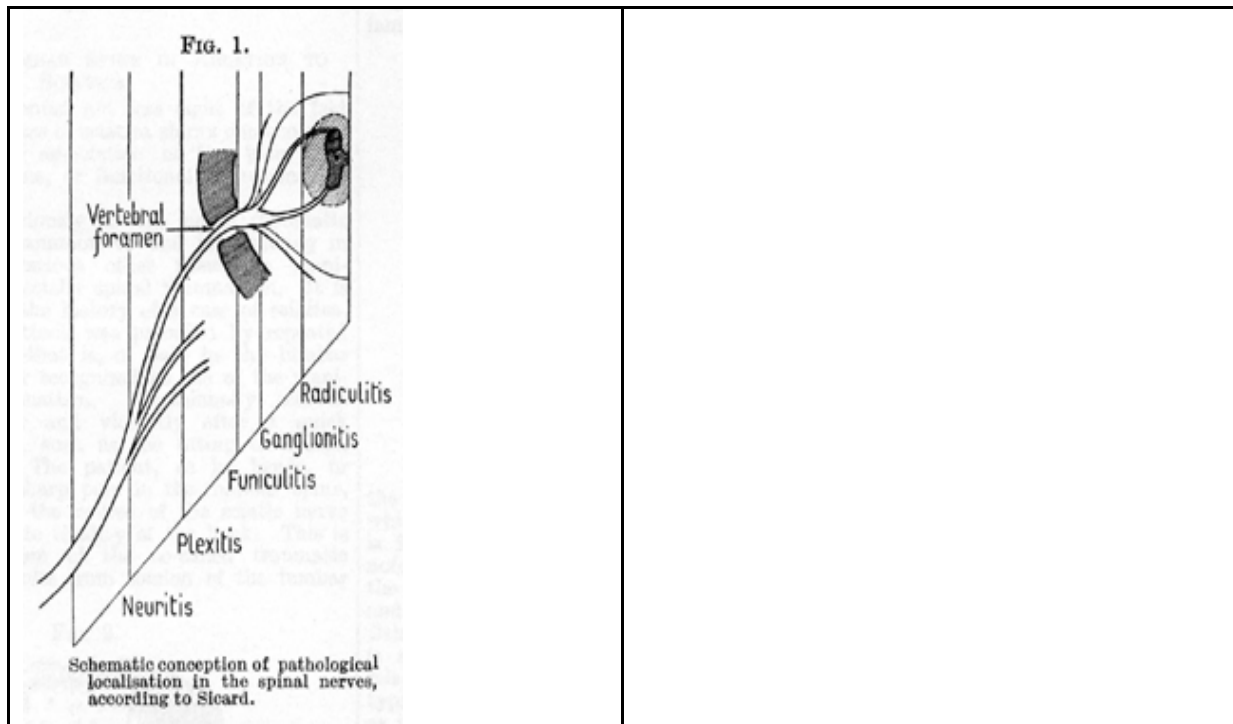
As is well known, the nervous system is responsible for the function of sensation. In the absence of nerve-fibres, there is no feeling, and hence no pain. There arise in every organ and every part of the body simple sensory nerves and also sympathetic sensory fibres, which, by various routes and various relations, conduct impressions from the periphery to special receiving centres, and such impressions as reach the cerebral cortex are perceived there as sensations. Any irritation of these sensory fibres in any part of their course induces, through stimulation of the cerebral cortex, the sensation of pain. Thus the cause of the pain may have situations as diverse as the types of irritation.

Localisation of site of irritation

As regards diagnosing the level of irritation: if one considers the enormous length of the sensory tracts, one will realise how difficult it may be to localise the cause of pain. The irritation may occur in the peripheral nerve, in the plexus, in the spinal root, in the spinal cord, or in the brain. Pain, as such, has no localising sign. In quality there is no difference between pain originating in the spinal cord and in the peripheral nerve. There are certain gradations in quality, but these are too subtle and variable to have distinctive value. For example, the pain of sympathetic origin, the so-called causalgia has a burning, dry character. Root pains tend to be stabbing, crushing, or lightning pains, but as these phenomena are subjective and impossible to measure, we are dependent on the patient's description of them, which introduces an element of uncertainty. Conversely, it is well known that pain of central origin may be referred to the periphery, the classical example being the paraesthesia of amputated limbs. Alternatively, pain of peripheral origin may be referred to the centre.

For all this, there exist certain characters distinctive of certain levels of irritation, from which can be constructed a topographical classification of types of pain. From early times the term neuralgia has been reserved for pain arising in the peripheral nerve, that is the segment of nerve formed by the fusion of various roots in the plexus and extending to the periphery of the limb. Dejerine drew the clinical picture of radiculitis, a form of pain resulting from disease of the nerve roots in the plexus. An even more careful analysis of clinical findings has enabled Sicard and his pupils to differentiate another type which is due to stimuli affecting the segment of nerve between the spinal root and the plexus, as it traverses the intervertebral canal. Sicard has named this part of the nerve trunk the funiculus, the little cord, and has called the pain syndrome, due to irritation at this level, funiculitis. Sicard and his pupil, Forestier, have attempted to give an anatomical and clinical basis to the funicular syndrome, in contrast to the radicular syndrome of Dejerine (Fig. 1). Following the same lines to a somewhat theoretical conception, Sicard hopes in the future to attain to other

topographical differentiations of pain, such as plexitis and ganglionitis namely, the response to irritation of the limb plexus and of the spinal ganglion.



This is not the time to indulge in a critical examination of these new ideas of localisation of pain, but the most important result of these researches is the emergence of a new factor in the causation of neuralgia that is to say, the vertebral element, or to be more general, the influence of the skeleton. The idea is not new, indeed, that a nerve may be irritated in the canal or foramen which it traverses. Long ago it was recognised that many types of trigeminal neuralgia, facial, suprascapular and Arnold's occipital nerve neuralgia, as well as ulnar and radial, are the result of mechanical irritation of the nerve trunk by the bony foramina, or osteo-periosteal canals. Sicard has re-named these conditions also; he calls them "nevrodociis" derived from two Greek words: *Neuron* = nerve; and the verb *Dekon* = to contain. Nevrodociis, therefore, indicates nerve pain due to stimulation of the nerve by the bony foramen or canal which contains it. We shall frequently make use of this term, which is descriptive and comprehensive.

VERTEBRAL AND PELVIC FACTORS IN SCIATICA

As regards the pathology of sciatica, the importance of vertebral and pelvic factors was pointed out some years ago by an American orthopaedic surgeon. Goldthwait, of Boston. Goldthwait was the first to investigate the problem from its anatomical and mechanical aspects, and his work gave inspiration to a series of researches, which have thrown great light upon the matter. He was also the first to draw attention to the frequency of certain congenital anomalies of the Spinal column, such as sacralisation of the fifth lumbar vertebra, and variations in the posterior articulations, while he pointed to the possible connexion between these abnormalities and sciatic pain. Goldthwait's views, after they had been defined and extended by other workers, became so popular that in a short time the subject of sacralisation of the fifth lumbar, and its association with sciatica, took a prominent place in medical

literature. This was natural enough, for the desire to find an anatomic basis for sciatica and the actual frequency, of morphological variations of the fifth lumbar vertebra naturally led to acceptance of Goldthwait's ideas and the recognition of the syndrome, which French authors have recently designated painful sacralisation of the fifth lumbar vertebra. The fifth lumbar vertebra is the foundation-stone of the vertebral column, and it is also much subject to congenital variations, because it is intermediate, in position between two segments, the lumbar and the sacral, and has no fixed character. Thus, it is not uncommonly seen to resemble a sacral more than a lumbar vertebra. Its transverse processes may be so wide and deep that they exactly resemble the alae of the sacrum, and in extreme cases it is impossible to distinguish the fifth lumbar from the first sacral. The anomaly may be symmetrical or unilateral.

What connexion is there between the presence of these abnormalities and the development of sciatica? The connexion can easily be divined. In the intervertebral foramen, between the fifth lumbar and the first sacral, runs the fifth root of the lumbo-sacral plexus, a root which is the principal constituent of the sciatic nerve. If the process of the fifth lumbar is wider and deeper, as in these cases of so-called sacralisation, then lumen of the canal is narrowed and lengthened, the fifth root may be irritated or compressed as it runs through the canal. Anatomical and radiological studies have demonstrated that sacralisation of the fifth lumbar occurs far more frequently than was formerly recognised. This discovery suggested for a time that the true cause of sciatica had been finally discovered. Some surgeons were induced by this discovery to treat sciatica by removal of the fifth lumbar transverse processes. They expected that, as soon as the process was removed and the canal thereby enlarged, the nerve would have free course and the pain be cured. But unfortunately, results have not always corresponded to their expectations, and criticism has now overturned the elaborate and somewhat theoretical edifice, erected on the base of lumbar sacralisation. It cannot be denied that sacralisation may sometimes be the cause of sciatica, but, on the other hand, the anomaly is frequently found to be present without any associated symptoms, referable to the lumbo-sacral plexus. It, must also be borne in mind that the fourth lumbar contributes to the formation of the plexus, and it is often possible to demonstrate that the pain is due to involvement of this root and not of the fifth, which alone could be affected by sacralisation. Finally, if we consider the close relation existing between the development of the vertebral column and of the spinal cord in the embryo, we should expect that with reduction of the inter vertebral foramen would be associated a smaller nerve-root, so eliminating the probability of compression. For the above reasons, and others, opinion now is in favour of considering lumbar sacralisation as one, but by no means the most frequent or severe, the causes of sciatica.

In view of the intimate relation of the roots of the nerve to the sacro-iliac synchondrosis, it has been stated that peculiarities and diseases of this joint may cause sciatica. This hypothesis lacks anatomical or clinical support; indeed, the recent investigations of Danforth and Wilson seem to exclude it.

ANATOMY OF LUMBAR SPINE IN RELATION TO SCIATICA

For all this, we must not lose sight of the fact that the study of cases of sciatica shows one constant factor—namely, the association of the pain with anatomical alterations, or functional disturbance of the lumbar spine.

We referred previously to the name rheumatic sciatica, and it is common to find it occurring in individuals with various other rheumatic manifestations, more especially spinal rheumatism. It is common, in taking the history of a case of sciatica, to learn that the attack was preceded by repeated bouts of lumbago—that is, of pain in the lumbar region, which is now recognised as one of the manifestations of rheumatism. Occasionally sciatica comes on suddenly and violently after a quick stooping movement, such as the lifting of a load from the ground. The patient, as he bends, or rises, feels sudden sharp pain in the lumbar spine, which shoots down the course of the sciatic nerve and causes immediate rigidity of the back. This is the usual mechanism of the so-called traumatic lumbago which results from torsion of the lumbar articulation and almost always causes sciatica cases of Pott's disease, involving the lumbar vertebrae, are often tormented with violent sciatic pain. In them the sciatica is secondary, but its existence demonstrates the close connexion between a vertebral lesion and sciatica.

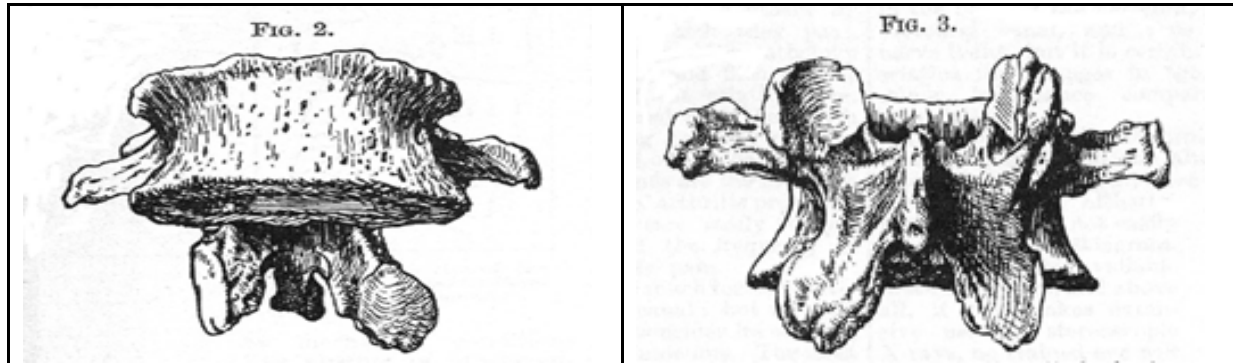
Many neuralgias of the trunk, upper limb, even of the head and face, take origin in some skeletal peculiarity in fact, are the result of compression, or strain on nerves, or nerve roots, where they traverse bony canals. These are the ones comprised by Sicard under the name "nevrodicitis"

The peripheral nervous system is composed of bundles of nerve-fibres, which in escaping from the spinal canal must traverse a series of bony foramina at the sides of the vertebral column, the so-called intervertebral foramina. Hence the peripheral nerves are liable to be affected by the condition of the vertebral column and more especially by the inter-vertebral foramina. In view of the important part these canals play in the pathology of neuralgia, it was desirable to study carefully their anatomical features and their relationship to the nerve roots. Anatomists and clinicians have shared the labour, and thanks to their investigations new light has been thrown on the pathogenesis of peripheral neuralgia.

What is the result of their studies? For the sake of clearness, we will first deal with the results of anatomical research, and later with clinical features. We shall restrict ourselves exclusively to the points which bear on the pathology of sciatica.

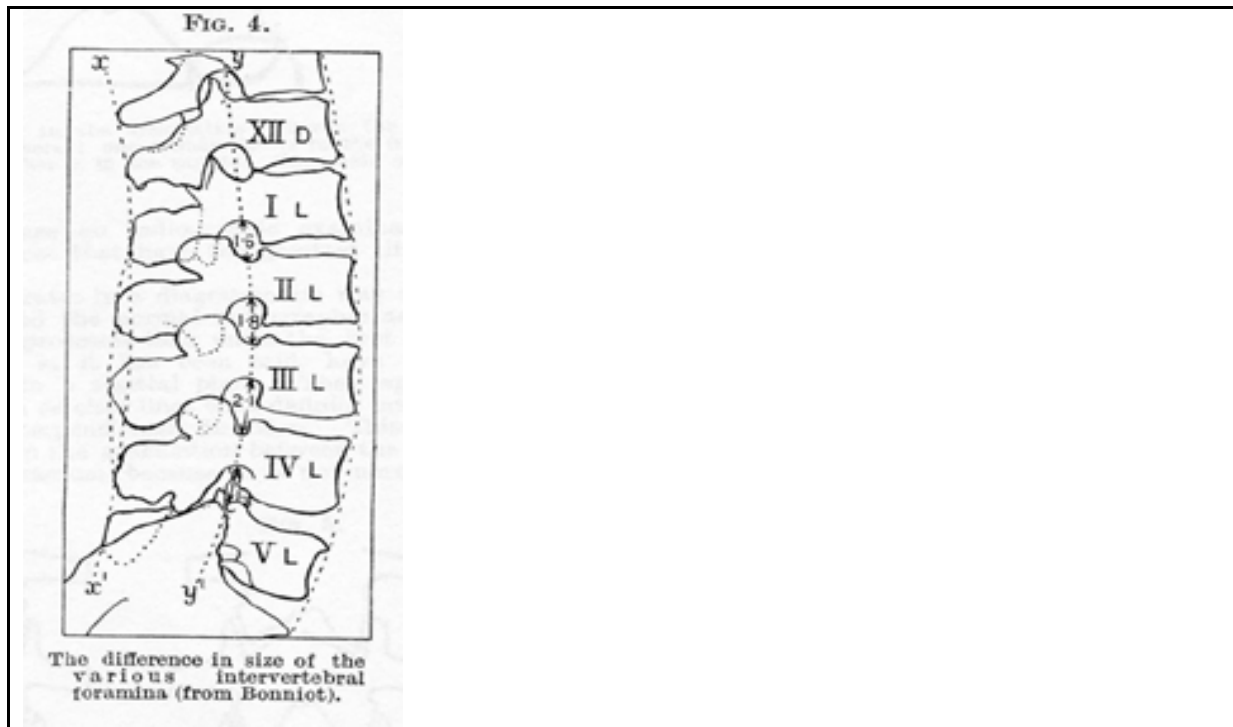
In general, the anatomy of the lumbar spine is familiar, but it seems worth while to emphasise the composition of the intervertebral canals through which the nerve roots emerge. In brief, the canal is formed as follows : Above is the intervertebral notch. In front is a little of the posterior part of the body above, a little of the intervertebral disc, and a little of the posterior part of the body below. Behind is the posterior articulation, and this last is a feature of considerable importance when the relations of the nerve roots are considered. The typical posterior articulation of the lumbar region, as it is depicted in anatomy books, is one with the articular facets placed in the sagittal plane. Only in the joint between the fifth lumbar and first sacral are the facets placed in the frontal plane, an arrangement which, as noted previously, is characteristic of the thoracic region. All the same it is safe to say that for the lumbar facets there is no fixed type. An investigation which I made on numerous dissections showed me that individual variations are very common indeed. This observation is confirmed by the study of many hundreds of X rays. But if variations in the angles of the facets are relatively unimportant when the angle does not diverge much from that considered normal, yet they become of great significance when they are of a severe degree of abnormality, and when they are unilateral only, a character by no means uncommon. I called attention to these peculiarities more than fifteen years ago in an article devoted to congenital deformities of the spine. I re-examined this material in my study of the pathology of sciatica and found it not

uncommon to have one articulation in the sagittal plane, while its fellow was placed in the frontal plane. This arrangement may be met with in any of the lumbar vertebrae, but is most frequent in the articulations of the fifth lumbar with the first sacral (fig. 2 and 3). We already noted that these joints are normally placed in the frontal plane, but it may happen that while one remains so, the other is exactly sagittal.



These anomalies may have a two-fold effect on the intervertebral foramen ; firstly, they may alter its shape and reduce its capacity ; secondarily, by altering the mechanics of the spinal column, they may induce a localised arthritis, which itself may irritate the nerve trunk. This effect may also be produced by all the inflammatory processes that have their seat in the vertebral articulations, and we know how frequently this occurs. The diseased joint, by its swelling and deformity, changes the shape and capacity of the foramen, thus irritating and compressing the nerve within it. Hence the neuralgia, or neurodocitis.

Recent researches have shown that the inter-vertebral foramina are not all of the same size. The foramen between the fifth lumbar vertebra and the sacrum is always the smallest, that between the fourth and fifth vertebrae the next larger, and that between the fourth and third usually the next, although sometimes the second and third were about equal. Quite contrary to the size of the foramen or canal is the size of the nerve root enclosed. The fifth is always largest, the fourth next to the largest, and the third smaller as a rule, although sometimes the second and third roots were about equal in size (fig. 4.) In other words, the fourth and fifth lumbar roots are predisposed, on anatomical grounds, to be affected more than any others by changes in the canals through which they pass. This fact has an important bearing on the pathology of sciatica, seeing that the fourth and fifth lumbar roots constitute a large part of the sciatic nerve. When, furthermore, it is considered that the fourth and fifth lumbar vertebrae, owing to their position in the spine, are the most exposed of all the vertebrae to compression and strain, and hence are the favourite site of arthritic processes, one can easily understand the frequency of sciatic pain.



So much for the vertebral canal; but we must also consider its content, the funiculus. The most recent researches on this subject are those of Bonniot and Forestier. The conclusions of these two writers may be summarised as follows: the fourth and fifth lumbar nerves are those possessing the longest funicular portion of all those which constitute the lumbo-sacral plexus—namely, those with the longest course through intervertebral foramina. The funicular portion of the nerve, unlike the intraspinal portion, does not lie within the arachnoid, but is only clothed by dura mater, and is not bathed in cerebro-spinal fluid. Around the funiculus there is a very rich venous plexus, which is much influenced by mechanical conditions outside the funiculus. The absence of arachnoid, and therefore of a protective layer of fluid, exposes the funiculus to outside mechanical influences, such as do not affect the root, while the surrounding venous plexus puts it at the mercy of any congestion and stasis that may occur in the neighbourhood from many causes.

The intervertebral foramen for all these reasons constitutes a critical region, or as Sicard has happily named it, "*carrefour de la douleur*"—i.e., the crossroads of neuralgia. Any condition which modifies in the slightest degree the contents, or the container, at once induces a painful reaction, which is referred distally to the sciatic nerve.

Such conditions are discovered by X rays, or by clinical examination. The importance of X ray examination goes without saying, but it is necessary to be clear as to the interpretation to be placed on the X ray evidence. Up till now, many have paid more attention to alterations in the bodies and transverse processes than to modifications of the form and structure of the intervertebral canals. We have already referred to the fate of the so-called syndrome of painful sacralisation. The undue value given for a time to that syndrome distracted attention from phenomena of greater importance. It is undeniable that in certain cases the sciatica is caused by the sacralisation of the fifth lumbar, but the two phenomena are less frequently associated than has been asserted. The same may be said of all the forms of arthritis which affect chiefly the bodies of the vertebrae, and which are evidenced in X rays by bridges of bone uniting more or less completely, the bodies themselves. This X ray picture corresponds to the well-

known group of ankylosing disease, which pass under the name of arthritis deformans, ankylosing spondylitis, Bechterew's and Pierre Marie's diseases. Even in these it is possible that the morbid process, although mainly localised in the body of the vertebra, may influence the intervertebral canal, and thus indirectly irritate the nerve trunk, but it is certain that in the causation of sciatica the changes in the vertebral body are of minor importance compared to those in the articulations.

The abnormalities, deformities, and inflammations of these joints, and the alterations in form of the intervertebral foramen, have not been appreciated at their due value hitherto, because they are not easily recognised on a skiagram. But if one has available first-rate X rays, and above all, if one makes extensive use of stereoscopic X rays, no trained eye will fail to determine the form, size, relations, and structure of the foramina and also the articulations. I lay stress on this point, because nowadays in dealing with a case of sciatica everything depends on the estimation of the condition of the spinal column. No progress would have been made in the elucidation of this obscure problem, if X rays had not convinced us that idiopathic, or essential, sciatica is synonymous with spinal arthritis. If X rays had not shown the existence and frequency of arthritis, clinical examination alone would not have given us the clue to the just interpretation of the facts.

But, as I have said, to reveal the anatomical signs of vertebral arthritis, perfect radiograms and experienced examiners are indispensable. In many cases the alterations of the intervertebral articulations are not visible because the radiograms are imperfect, and often also vertebral arthritis is denied because its clinical manifestations have not been appreciated. The intervertebral articulations and foramina are two elements that are generally overlooked in the radiological examination of the spine, the attention of the examiner being commonly attracted to the condition of the bodies, the most conspicuous parts of the vertebrae. Almost always lateral views are neglected and stereoscopic radiograms are little used. It is not possible to judge rightly the conditions and proportions of the canals if lateral radiograms are not taken. And it is impossible to obtain a proper impression of the relations of the articular facets without a stereogram. However, the task is facilitated by the fact that it is the lumbar spine which is affected, the segment that lends itself best to a complete radiological study.

It would be very instructive to demonstrate the anomalies, deformities, and various forms of arthritis, which alter the intervertebral articulations and foramina, but to do so I should need the original skiagrams more particularly the stereoscopic ones, for the finer details are lost in lantern-slides.

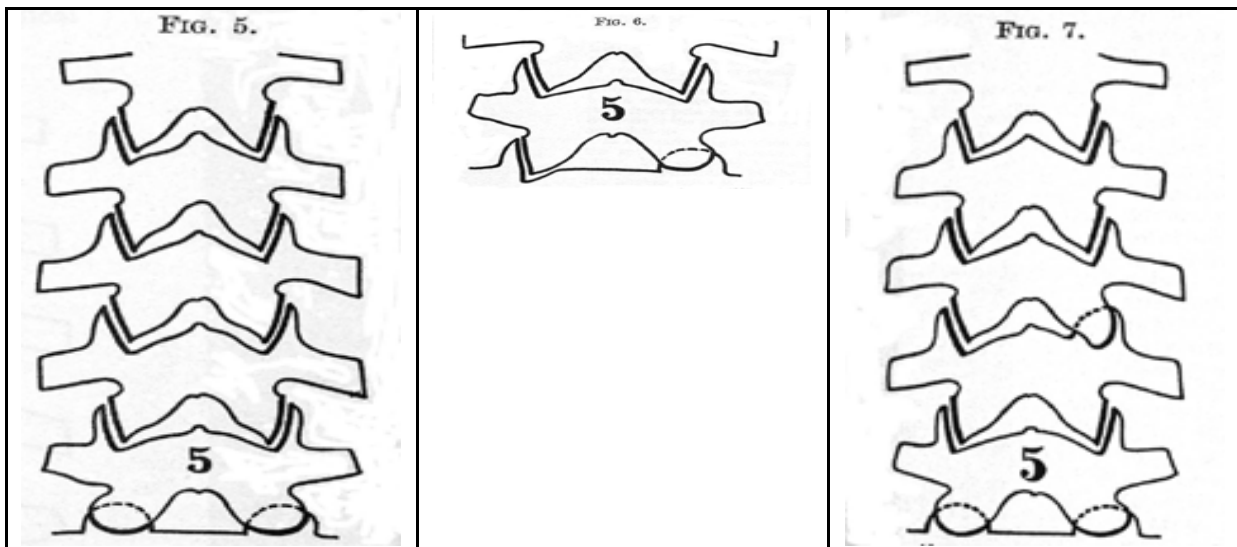
ALTERATIONS IN INTERVERTEBRAL ARTICULATIONS AND FORAMINA

I shall limit myself, however, to demonstrating those phenomena which can be found with greater frequency and ease on radiographic examination, and especially those that have the greatest clinical importance.

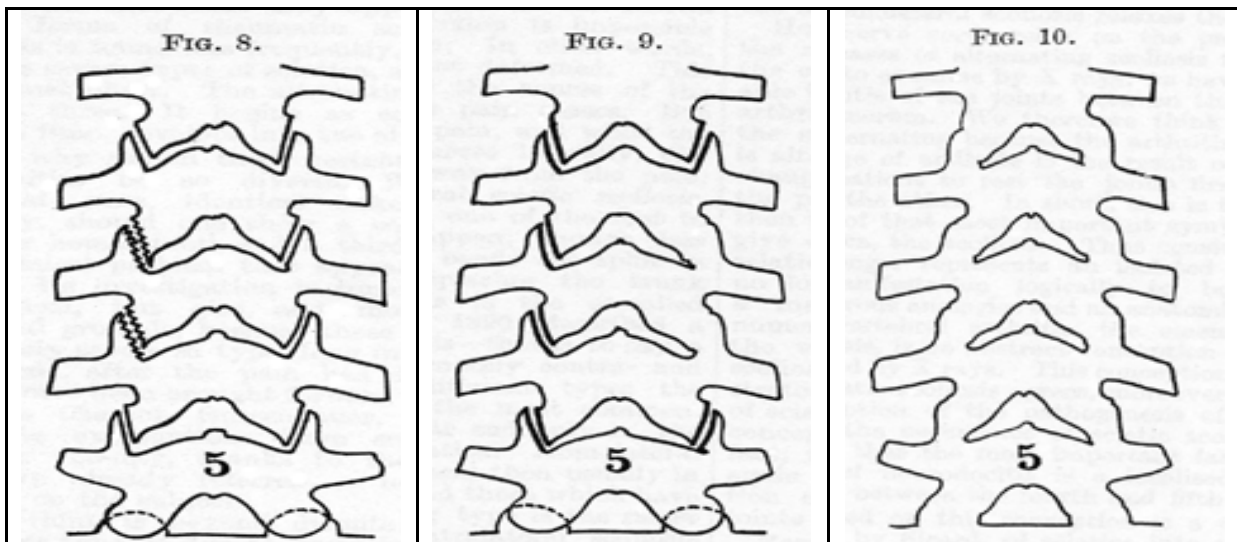
Fig. 5 demonstrates in a diagrammatic way what may be considered the normal radiographic aspect of the articular processes that unite the first four vertebrae, which, as it has been said, have their articular spaces in a sagittal plane. They appear upon the diagram as clear lines with definite borders and in almost perpendicular direction. This line does not appear in the articulation between the fifth lumbar and the sacrum, because it is not normally directed on a

frontal plane. If the conditions which I have stated above are kept in mind it will not be difficult to discover anomalies or anatomical alteration of the lumbar articulations.

Fig. 6 illustrates an anomaly that frequently appears in the relationship between the fifth lumbar and the sacrum. One articulation preserves the normal position, while the other assumes the radiographic characteristics that belong to the first four lumbar vertebrae. The same anomaly may occur in the articular relations between the other vertebrae (fig. 7.) To this condition, I have given the name of "anomaly of the articular tropism".



But that which interests us mostly is the proof of the phenomena which follow inflammatory processes of the articulations. They are in reality the same which radiograms demonstrate in every arthritis even though not vertebral. The articular surfaces instead of appearing smooth and parallel appear jagged and rough, as diagrammatically shown in fig. 8. With perfect radiograms it is possible to determine the structural condition of the articular tissues. It is not infrequent to find a localised ankylosis in one or another of the articulations. This is represented on the radiogram by absence of one or more articular spaces (See fig. 9.) The radiographic aspect of a total ankylosis is very characteristic, as the joint space has completely disappeared (fig. 10).



Nowadays the cause of sciatica is to be diagnosed more by a study of the X rays than of the clinical symptoms. This does not mean that one is to neglect investigation of the symptoms. Diagnosis, the constant preoccupation of the medical mind, is a conclusion drawn from a study of the facts which knowledge and experience enable us to perceive. The more numerous and objective the facts, the easier and safer the conclusion. But this judgment is born less of the bald assemblage of facts and scholastic classification of them, than of a reasoned analysis of their relation to one another, their logical interdependence. Longfellow has well said:

None but a clever dialectician
Can hope to become a great physician.
Logic makes an important part
Of the mystery of the healing art,
For without it how could you hope to show
That nobody knows so much as you know?

CLINICAL MANIFESTATIONS OF SCIATICA

Let us not, therefore, neglect the clinical manifestations of sciatica. Amongst the symptoms is a constant one that may well be called spinal. I mean the rigidity of the lumbar spine. Next to pain, this is the dominating feature of idiopathic sciatica. It is well known that there is no clear-cut clinical picture in this disease. Lasègue's sign-namely, the pain caused by extension of the knee with simultaneous flexion of the hip, is neither constant nor characteristic of idiopathic sciatica. Absence of the knee- and ankle-jerks, muscle atrophy, sensory changes, are all phenomena of value in certain cases, but cannot be called pathognomonic.

Even lumbar spasm cannot be correctly called a special symptom, for it exists in every case of irritation of the lumbar spine; nevertheless, it acquires great diagnostic value when it is associated with sciatic pain. It is absent in root sciatica and in all the secondary form of sciatica. On the contrary, it is always present, or nearly always, in the rheumatic, arthritic type. We have repeated that this type is due to joint disease. Every joint responds to irritation by contractures of the muscles which control its movements. This contracture represents a defensive reflex-that is, a reflex designed to protect the joint from pain. The contracture produces this defence by immobilising the joint. The joint is thus fixed in an attitude which may be called protective, an attitude which relieves it of pain. As we said, this attitude has nothing characteristic of vertebral joints or of sciatica. It is found in every painful joint, and each joint has its own special protective attitude. The vertebral column is nothing but a congeries of joints, and as such it protects itself from pain by assuming characteristic attitudes. Sooliosis is the protective contracture of the vertebral articulations.

In the early stages, when sciatic pain is not severe, the spinal column remains straight in the frontal plane, but complete forward flexion is impossible without aggravation of the pain. In other words, the lumbar spine is rigid, but not deformed. This rigidity may persist throughout the course of the disease and disappear when the pain ceases. But usually, soon after the onset of pain, and while the pain is increasing, the spine curves laterally, displacing the trunk to the side away from the pain. This is the so-called contralateral sciatic scoliosis, so-named by Brissaud, who was one of the first to study the subject. It can happen, though less frequently, that the contracture bends the spine in the reverse direction, thus displacing the trunk towards

the painful side. This is the so-called homolateral scoliosis. Remak, in 1890, described a type of alternating sciatic scoliosis -that is to say, a lateral curvature, which is alternately contra- and homo-lateral. Of these three different types the contralateral scoliosis is by far the most common, and is the one which may appear suddenly in the acute forms of rheumatic, sciatica. Homolateral scoliosis is found less frequently, and then usually in the less severe types of sciatica, and those which have a gradual onset. The alternating type is the rarest of the three. It begins as contralateral scoliosis and, in time, develops into the alternating form.

But why should these vertebral contractures and deformities be so diverse. Why in apparently identical cases, identical alike in duration and severity, should one show a contralateral scoliosis, another homolateral, and a third alternating? This is a clinical problem that appeared very difficult to solve. Its investigation is important, not only on theoretical, but also, and more particularly on practical grounds, because these deformities may be extremely severe in type, long in duration, and even persistent after the pain has disappeared. Hypotheses have been brought forward by men of authority such as Charcot, Gussenbauer, Hoffa, and Lorenz. But the explanations have seldom seemed convincing. Today, thanks to the studies to which we have already referred, a new light has been thrown on the subject.

One thing is beyond dispute: that scoliosis, of whatever type, is due to muscular contracture, which is itself a reflex, induced by the pain with the object of diminishing the pain. Ask the patient and examine him, and you will soon be convinced of this fact. Try to correct and overcome the scoliosis, and you will find the patient protest, because the pain immediately becomes unbearable. If you ask the patient he will tell you that the curvature came on spontaneously, and that he does not try to correct it, because that increases his pain. Thus the contracture and scoliosis have as their purpose the diminution of pain. How is this achieved? By what mechanism can these various contractures reduce pain? The commonly accepted explanation is that the attitude of the trunk, together with abduction and flexion of the affected limb, produces a relaxation of the sciatic nerve, and thus relieves the pain. But this hypothesis does not explain all the facts. Were this true, the scoliosis should be always of the same type, and all forms of sciatica should produce it, whereas we know it is characteristic of rheumatic sciatica. On the other hand, the mechanism becomes much more obvious, if we accept the arthritic origin of sciatica.

As was said, every arthritis produces contractures. Scoliosis is merely the contracture special to the spinal articulations. Joint contractures are not constant, but vary in type, depending on a number of factors. A classical example is the contracture of the hip-joint, which may take up a position of adduction, or of abduction. The contralateral scoliosis, which we said was the commonest, results in the separation of the articular surfaces of the intervertebral joints on the painful side and also widens the intervertebral canals. Thus, the contracture immobilises the joints, reduces friction of their surfaces, and diminishes any compression of the nerve-trunks.

Homolateral scoliosis relaxes the joints and makes the nerve cords relax on the painful side. In all the cases of alternating scoliosis that we have been able to examine by X rays, we have found a bilateral arthritis of the joints between the fifth lumbar and the sacrum. We therefore think that the scoliosis is alternating because the arthritis is bilateral. The change of attitude is the result of the need felt by the patient to rest the joints first of one side and then the other. In short, this is the explanation we give of that most important symptom of idiopathic sciatica, the scoliosis. Thus considered, the scoliosis no longer represents an isolated phenomenon, but a manifestation logically to be expected, with numerous analogies and an anatomic basis. Indeed, the vertebral arthritis, the essential cause of the scoliosis, is no abstract conception but

a fact demonstrated by X rays. This conception of the mechanism of sciatic scoliosis agrees, moreover, with the modern conception of the pathogenesis of sciatic pain. In fact, the occurrence of sciatic scoliosis proves once again that the most important factor in the causation of neurodocitis is a localised arthritis of the joints between the fourth and fifth lumbar vertebrae.

Based on this conception is a classification, proposed by Sicard, of sciatica into upper, middle, and lower, according as the seat of pain lies in the spine, in the pelvis, in the popliteal space, or in the leg. I personally prefer a more definite and comprehensive division into central and peripheral sciatica. The first includes root and vertebral sciaticas, the second includes pelvic, femoral, and popliteal ones.

Sicard has drawn attention to a phenomenon which, according to him, has great importance in the differential diagnosis of radicular from vertebral sciatica. We must refer to this phenomenon, although we feel some doubt as to its constancy and intrinsic diagnostic value.

Sicard's phenomenon depends on examination of the cerebro-spinal fluid. In root sciatica there is said to be a lymphocytosis; in funiculitis an increase in the albumin content, without lymphocytosis, a state of the fluid which Sicard and Foix have called cell-albumin dissociation.

The increase of albumin, which is supposed to be peculiar to funiculitis, is due, according to Sicard, to the obstruction to the venous circulation by inflammation and compression in the canal. The control experiments which we have carried out on numerous patients have not led us to any definite conclusion in the matter. Beyond the symptoms to which we have referred, idiopathic sciatica shows others of an eminently neurological character. But their diagnostic importance is relative. Naturally an inflammatory reaction in a mixed nerve like the sciatic induces, besides pain, symptoms of trophic, sensory, motor reflex, and sympathetic nature. Often there is general reduction of the muscles of the whole limb, more particularly of the thigh and leg. In some severe cases one finds paresis or paralysis of the external popliteal, but tests have never shown the electrical reactions of degeneration. More important is the condition of the reflexes. The ankle-jerk is the one most often affected. Frequently is abolished, nor is it rare to find it diminished. We have seen cases in which, many years after the disappearance of every symptom of sciatica, the ankle-jerk was still absent. The knee-jerk also varies and its disappearance is by no means rare.

THE SCIENTIFIC TREATMENT OF SCIATICA

This seems to me the moment to answer a question which I imagine some of you are longing to put to me: What influence have these new conceptions of the pathology of sciatica on the treatment of the pain itself? If a treatment initiated on pathological grounds produces the desired effect, that fact of itself constitutes the most certain proof that the cause of the disease has been correctly ascertained. The results which I have obtained in a large number of cases of idiopathic sciatica by applying treatment based on the conviction that it is the consequence of spinal arthritis, demonstrate, in my opinion, that my conviction is correct.

It is unnecessary to enumerate the therapeutic measures which have been applied in sciatica. These measures were almost exclusively symptomatic. The cause being unknown, an attempt

was made to treat the results, and efforts were made to overcome the pain with all measures, chemical, physical, mechanical and surgical, at the disposal of the profession.

Once convinced that idiopathic sciatica takes origin in spinal arthritis, we followed out in its treatment the two fundamental principles of treatment for any non-specific arthritis -namely, active hyperemia and immobilisation. Active hyperemia, obtained by the action of heat on the part, causes vasodilatation in the neighbourhood of the joint and hence an active interchange of fluids, which by self-immunisation has a curative effect on the arthritis. Immobilisation rests the joints and relieves it from mechanical irritation.

The technique of this treatment is briefly as follows:

In the acute stage the patient is rigorously confined to bed. When the diagnosis has been confirmed, active hyperemia is begun, which consists in a daily hot-air bath. The bath is given by one of the numerous forms of apparatus that have been designed for this purpose. We greatly prefer Bier's apparatus, which consists of a wooden box, adapted to contain the part of the body which it is desired to expose to the action of heat. Into this box is driven a current of hot air produced by a spirit lamp. With Bier's apparatus it is easy to attain the maximum temperature which the body will stand. If the general condition of the patient allows, the bath will be given daily for 30 to 40 minutes. In the first few days the temperature will rise to about 90° C later to a maximum of 120° to 125°. The hot bath will be followed by general massage. In the great majority of cases one finds, after the first few baths, an aggravation of the pain, quickly followed by decisive improvement.

The moment the patient is fit to stand for a time without pain the second stage of treatment is initiated namely, immobilisation. This is obtained by means of a plaster jacket. I cannot stop to describe the technique of the making of this jacket. A few general rules must suffice:

- 1- The jacket must give fixation to the pelvis and trunk, except the shoulders.
2. It must only immobilise, not attempt to correct. Even if severe scoliosis is present it must not be interfered with.
3. The jacket must never be left on any longer than is necessary for the setting of the plaster, which is about 30 minutes.

Allow me to lay stress on the point that the jacket must immobilise and not attempt to correct. Its only purpose is to rest the inflamed joints. We said before that the spinal contracture represents the patient's own method of reducing pain. To correct the contracture is to exacerbate the pain. The contracture must disappear spontaneously as the result of immobilisation. Experience has shown that leaving the corset on causes within 24 hours a very severe spasm of pain. The sciatica case cannot endure any compulsory position for more than a few moments. Pain compels him to change the position of his spine every few minutes. For this reason the corset must be removed as soon as it is finished. It is to be worn daily for increasing periods, until the patient is used to it. This will be within a few days. Usually by the end of a week the patient is able to tolerate the corset continuously. Meanwhile the hyperemia treatment is continued. This treatment is usually completed in 18 to 20 baths. On the contrary, it is impossible to fix the end of the immobilisation period. Usually, after two or three months, the plaster jacket can be replaced by a celluloid corset. In mild cases of spinal

sciatica immobilisation will be continued for not less than six months ; in more serious cases the jacket may need to be worn for more than a year.

This is not the time to dwell at length on statistics of the results of this treatment Long experience has shown me that it rests on a good foundation, because the results are good in the majority of cases. There are, indeed, very severe cases which do not improve with conservative treatment. Some years ago Sicard advised resort in these cases to surgical measures that is, laminectomy. According to Sicard, laminectomy-namely, removal of the laminae of the fifth, fourth, and sometimes the third lumbar vertebra-would result in decompression of the funiculi. In some cases operated on by Robineau, Sicard observed that the dura mater was irregular with scar tissue, which he thought might have some bearing on the causation of sciatica. Sicard regards the results of laminectomy as most favourable.

I have only encountered a single case of arthritic sciatica which resisted all conservative treatment, and in which I felt compelled to resort to surgery. The case was that of a man of 52, who for more than 30 years suffered from periodic attacks of sciatica, and who for some months has been unable to assume the upright position. There was severe lumbar contracture, which had produced a rigid, contralateral scoliosis. The X ray showed advanced pathological changes in the bodies and articulations of the fourth and fifth lumbar vertebrae. In this case I did not limit myself to carrying out a laminectomy, because it seemed to me an operation insufficient to relieve compression of the funiculi. The vertebral laminae take no part in the formation of the intervertebral foramina. In order to decompress the funiculi it is necessary to open the bony canal, which can only be done by resecting the posterior articulations, which is what I did in my case. After removing the laminae of the fifth, fourth, and third lumbar vertebrae, I resected the posterior articulations which unite the fourth to the fifth lumbar, and it to the sacrum. Thus I succeeded in completely exposing the fourth and fifth lumbar nerves on both sides. I did not see any macroscopic changes in the meninges, in the roots, or in the funiculi. Complete success resulted. In a few days the patient was free from all pain ; at the end of a month he could get up and walk without difficulty in a plaster jacket. The improvement is maintained more than three years after the operation. This result shows that even for the most severe cases of sciatica there exists a cure, and it also demonstrates once again that the explanation of the pathology of sciatica which has been put forward in this lecture is a rational one.

CONCLUSIONS

Sciatic pain is symptomatic of vertebral arthritis excepting in those rare cases in which it is a symptom of a neuritis of specific nature. Sciatica is a neuralgia caused by pathological conditions of the intervertebral foramina and especially of the intervertebral articulations. In other words, sciatica is a symptom of neurodocitis and lumbarthritis.

The terms rheumatic sciatica and idiopathic sciatica should be substituted by the more precise and adequate one of arthritic or vertebral sciatica.

To treat the sciatica, it is necessary to treat the arthritis.

The treatment of vertebral arthritis is based upon the same principles as the treatment of all other arthritis of non-specific origin, therefore active hyperemia and immobilisation. When

these two methods are inefficacious it will be necessary to resort to a resection of the diseased articulations.