A CASE
OF
LIMITED LESION OF CERTAIN SPINAL
NERVES

BY SECONDARY CARCINOMA OF THE VERTEBRÆ
AND DURA MATER.

BY

RAYMOND JOHNSON, M.B., B.S., F.R.C.S.,
ASSISTANT SURGEON TO THE GREAT NORTHERN HOSPITAL AND THE
VICTORIA HOSPITAL FOR SICK CHILDREN; LATE SURGICAL
REGISTRAR, UNIVERSITY COLLEGE HOSPITAL;

AND

GEORGE R. MURRAY, B.A., M.B.CAMB.,
LECTURER ON PATHOLOGY IN THE UNIVERSITY OF DURHAM COLLEGE OF
MEDICINE; FORMERLY HOUSE PHYSICIAN TO UNIVERSITY
COLLEGE HOSPITAL.

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M. D—, a married woman, æt. 44, was admitted into University College Hospital on March 4th, 1889, under the care of Dr. Ringer, to whom we are indebted for his kindness in allowing us to bring the case before the notice of this Society. The patient's illness dated from September, 1888, when she first experienced dull aching pains in the region of both scapulæ. These pains persisted, and about six weeks later the patient discovered that she had lost power in the second finger of the right hand. This was followed by gradual loss of power in the other

fingers and in the hand, accompanied by progressive muscular wasting. The same changes soon followed in the left hand. At this time the patient also experienced constant pain in both arms, with occasional shooting pain in the same position. She became gradually worse, so that in December, 1888, she took to her bed, and remained there until her admission to the hospital. During January and February, 1889, no improvement occurred in the severity of the pain in both shoulders and arms, whilst the muscular wasting and loss of power steadily progressed to the forearms and arms. No further symptoms developed. It may be stated that the patient's previous health had been good, and there was no evidence of syphilitic taint.

The condition of the patient when admitted to the hospital in March, 1889, was as follows:—She constantly assumed the dorsal decubitus, and her face wore an anxious expression indicative of long-continued pain. Her mental condition was clear, and there were no symptoms of cerebral disease. She complained of continuous aching pain in both infra-spinous fossæ, and in the interscapular region at the same level, the pain extending down the arms; also of shooting pains in the upper limbs, more marked below than above the elbows. The distribution of the pain in the upper limbs was diffused, and bore no apparent relation to the course of the nerves. There was no tenderness over the infra-spinous fossæ, but slight tenderness over the spines of the vertebræ at this level. Pressure was painful along the inner side of each upper arm, and there was some general tenderness over both forearms, most marked, however, along the line of the median nerves. There was no anæsthesia, and no loss of muscular sense. The patient could readily appreciate painful and simple tactile impressions, and the painful parts were especially sensitive to cold.

Condition of the muscles.—There was considerable wasting of the *supra-spinatus* and *infra-spinatus* muscles on each side. When the arms were raised the upper fibres

of the *trapezius* contracted, and they were not atrophied ; the lowest fibres of the muscle for the width of one inch stood out when the arms were passively raised ; the intermediate part of the muscle on each side was paralysed and atrophied. The *levator anguli scapulæ* and *rhomboids* were normal on each side. The *serratus magnus* contracted with fair strength, but was apparently somewhat wasted. The *latissimus dorsi* was much atrophied. The *deltoid* possessed considerable power, and was not wasted. The sternal and costal fibres of the *pectoralis major* on both sides were much wasted and did not contract, but the clavicular fibres were not wasted and contracted well. The *triceps* was much atrophied, especially on the right side, where the power of extension of the elbow was nearly lost. Each *biceps* muscle acted fairly strongly. There was considerable wasting of the *extensors of the wrist and fingers*, and there remained but slight power of extension of the wrist and none of the fingers. Pronation and supination could be performed feebly. The *supinator longus* was not atrophied, and contracted readily. The *flexors of the wrists and fingers* were atrophied, flexion of the wrist being especially feeble on the right side. All the intrinsic muscles of the hand and thumb were greatly atrophied, and no movement whatever of the thumb or fingers could be executed. All the joints of the fingers were in a position of partial flexion. There was wasting of the *intercostal muscles* in the first three spaces of each side.

It is thus seen that the loss of power and the muscular wasting were nearly symmetrical on the two sides, being in the case of certain muscles only slightly more marked on the right than the left.

The muscular power and sensation in the lower limbs were good ; the patient could walk easily. The knee-jerks were normal, and there was no ankle-clonus.

There was no weakness of the muscles of the face or orbits. The pupils were equal, and reacted readily to light and accommodation.

In the upper and outer quadrant of the right breast was a moderately hard, rounded tumour, as large as a walnut. Its outline was sharply defined, but the growth appeared to be intimately connected with the surrounding breast-tissue. The nipple was not retracted, but was loosely held to the tumour. The latter was unconnected with the skin, and moved freely on the surface of the pectoral muscle. No enlarged glands could be felt in the axilla.

During the first ten days that the patient was under observation no noticeable change occurred; the pains in the upper limbs were severe, but were relieved by morphine and antipyrin.

On March 14th the patient began to suffer from shortness of breath, and had a weak, ineffectual cough.

On the 27th the note states that the pains, especially in the forearms, were very severe. There was distinct fulness in the neck above the right clavicle, and in the region of the thyroid gland. There was slight dulness below the right clavicle. The tumour in the breast was steadily increasing in size.

On the 29th the respiratory power was much weaker, and mucus was evidently accumulating in the lungs. With inspiration the lower chest expanded, but the abdominal wall receded; there was scarcely any movement of the upper part of the chest. With expiration the recti abdominis muscles contracted strongly. The knee-jerks were slightly increased, and slight ankle-clonus could be obtained.

On the 30th the patient was sinking rapidly. The power of flexion of the right wrist-joint had entirely disappeared; both wrists could still be extended. The elbows could be flexed. Enlarged glands were detected in the right axilla.

Death occurred on April 4th, 1889, seventeen days after the patient's admission into the hospital.

Autopsy.—The *spinal cord* was removed in the usual manner. The *dura mater* was considerably thickened in

the region of the cervical enlargement, where its anterior surface was strongly adherent to the bodies of the vertebræ. On slitting up the dura mater it was found to be somewhat adherent to the pia mater in the region of the thickening, especially behind. The thickening of the dura mater was almost confined to its anterior half, the posterior half being only slightly thicker than natural. The thickening was most marked opposite the origin of the anterior roots of the first dorsal nerve, where it measured nearly a quarter of an inch. Above and below this point the thickening gradually became less marked, ceasing above opposite the upper limit of the origin of the anterior roots of the sixth cervical nerve. Below, the greater part of the thickening ended opposite the roots of the fourth dorsal nerve, but on the right side a narrow strip extended downwards as far as the origin of the roots of the sixth dorsal nerve. Thus the fibres of the sixth, seventh, and eighth cervical, and the first, second, and third dorsal nerves on both sides were all involved in what on subsequent microscopical examination proved to be a carcinomatous infiltration of the dura mater. On the right side the fourth and fifth dorsal nerves were also partially involved. The outer surface of the infiltrated dura mater was rough and adherent to the posterior surface of the bodies of the vertebræ, which were also infiltrated with new growth; the inner surface of the dura was, however, smooth.

Muscles.—The *supra-spinatus* and *infra-spinatus* were pale in colour and atrophied. The *latissimus dorsi* was very pale and much atrophied. The clavicular fibres of the *pectoralis major* were dark red in colour and normal in bulk, whilst the sternal and costal fibres were pale in colour and much atrophied, presenting a striking contrast with the normal upper part of the muscle. The *pectoralis minor* was pale and wasted. The *biceps* was normal in appearance, but the *triceps* was much atrophied. The *intercostal muscles* of the three upper spaces were pale and wasted; the fourth and fifth appeared to be slightly

affected, whilst the sixth and lower ones presented a natural appearance. The *trapezius* was normal in appearance, and the paralysed middle part of the muscle was not obviously atrophied.

Breast.—In the upper and outer quadrant of the right breast was situated a rounded tumour as large as a Tangerine orange. In the appearance of its cut surface and in its relations to the surrounding tissues it presented the characters of a carcinoma. The remainder of the breast tissue had a normal appearance. Several axillary lymphatic glands were infiltrated with soft white growth. The *superior mediastinum* was filled by a mass of growth which extended back to the spine and infiltrated the anterior common ligament. The body of the sixth cervical vertebra and the upper part of that of the seventh were very dense and of a yellowish white colour, contrasting markedly with the pink appearance of the others. The intervertebral discs appeared normal.

The left internal jugular and innominate veins were dilated, whilst the right were contracted. At the junction of the two innominate veins a mass of growth projected into their lumen, but the intima remained intact. There was firm adherent clot in the right subclavian and axillary veins as low as the lower border of the subscapularis.

The *left lung* was healthy, the *right* was universally adherent.

The *thyroid gland* was enlarged and infiltrated with nodules of soft white growth, the largest being half an inch in diameter.

Abdomen.—The *intestines* were natural. In the end of the *vermiform appendix* was an oval mass of growth measuring seven eighths of an inch by half an inch. It appeared to have arisen in the subserous tissue, and did not involve the mucous membrane. In the mesentery of the lower ileum were several infiltrated glands, and others lay on the front of the aorta.

The *liver* and *spleen* were normal.

Each *kidney* contained two nodules of soft white growth,

those in the left being in the substance of the organ, whilst those in the right lay beneath the capsule.

Both *supra-renal capsules* were enlarged and extensively infiltrated with degenerating new growth.

The *right ovary* measured $3\frac{3}{4}$ by $2\frac{1}{4}$ inches, and was divided into two unequal parts. The larger consisted of a mass of soft pinkish-white growth, whilst the smaller presented a fine spongy mesh-work, the spaces containing a thin mucous fluid. The Fallopian tube was normal.

The *left ovary* measured $3\frac{1}{2}$ by $2\frac{3}{4}$ inches; it was infiltrated throughout with new growth. The Fallopian tube was normal.

Brain.—The membranes were natural. At the posterior end of the right gyrus fornicatus was a degenerated mass of growth as large as a small marble, dark in colour, and almost diffuent. It readily separated from the surrounding brain-substance, leaving a smooth-walled cavity. There was very distinct bulging of the cortex of the left hemisphere over the posterior end of the frontal and lower end of the ascending frontal convolutions. On section this was found to be due to a cavity extending to within about half an inch of the surface. It contained a grumous fluid, and was about the size of a small horse-chestnut. It was lined by soft broken-down growth. The growth extended down to the roof of the Sylvian fissure. Another small mass of growth lay three quarters of an inch behind this, and rather deeper in the white matter.

Almost exactly symmetrical growths were found on both sides of the brain in the middle of the internal orbital convolution, and also on the inner parts of the temporo-sphenoidal lobes. A small nodule lay in the white substance beneath the floor of the descending cornu of the right lateral ventricle, and another in the anterior part of the left half of the pons. The left hemisphere of the cerebellum was the seat of five separate nodules of growth, and two nodules lay in the right side.

Microscopic examination.—Sections of the *spinal cord*

were made at different levels between the origin of the third cervical and third dorsal nerves, and stained with aniline blue-black or carmine. In all the sections examined the grey matter was healthy. There was a tract of slight ascending degeneration in the postero-external and postero-internal columns on each side. On examining the sections from below upwards this tract was first distinctly seen at the level of the roots of the eighth cervical nerve. Here the most distinctly marked part of it lay at the inner side of the posterior cornu for about the middle two fourths of the distance between the posterior commissure and the posterior surface of the cord. The anterior part of the tract extended right across the postero-external column; the posterior part curved outwards with the posterior cornu, and was continued as a narrow strip backwards to the point of entrance of the posterior roots. At the level of the sixth cervical root it was more distinct than in any other section, and reached from the posterior commissure to the posterior surface of the cord. It occupied the inner third of the postero-external column, and was expanded laterally at its anterior and posterior extremities. Just behind the commissure it extended into the postero-median column, of which it involved the anterior third. In the upper cervical region the tract occupied only the anterior fourth of the postero-internal column and the inner half of the anterior third of the postero-external column.

All the organs which were the seat of secondary growths were also examined microscopically, and these growths were found to agree in all essential points with the structure of the primary one in the breast. They were, however, all softer than it, and showed a correspondingly larger proportion of cellular elements, and a greater tendency to degeneration.

Remarks.—Our knowledge of the functions of the roots of the spinal nerves is derived from three sources: experiments on animals, dissections of the human subject, and clinical observation confirmed by post-mortem examina-

tion. We bring forward this case in the hope that some of the facts observed may help to increase the data of our knowledge derived from this last source of information.

The chief interest of the case arises from the fact that the upper limit of the growth involving the cervical nerve-roots was sharply defined. Thus, whilst the sixth nerve-root was involved, the fifth remained unaffected. We have thus a lesion which closely resembles an experimental one, and such as we do not often have an opportunity of observing in man. This distinct limitation of the lesion is also borne out by the condition of the muscles, which were examined at the post-mortem. The difference between the atrophied and the healthy muscles was very marked, being especially striking in the pectoralis major, where the lower part was pale and atrophied, whilst the clavicular fibres retained their natural colour and appearance. From this we may conclude that the muscles supplied from this part of the spinal cord which remained healthy received at least the greater part of their nervous supply, if not all, from the fifth cervical or a higher root; whilst, on the other hand, the affected muscles were supplied by the sixth cervical and the lower roots which were involved in the lesion. Thus the levator anguli scapulæ, the upper part of the trapezius, rhomboids, deltoid, the clavicular fibres of the pectoralis major, biceps, supinator longus, and supinator brevis were supplied by fibres coming from the spinal cord in the fifth, or possibly higher nerve-roots. On the other hand, the supra-spinatus, infra-spinatus, middle part of trapezius, serratus magnus, sternal and costal fibres of the pectoralis major, pectoralis minor, triceps, extensors of wrist and fingers, flexors of wrist and fingers, latissimus dorsi, the intrinsic muscles of the hand, and the upper three intercostal muscles, received their supply from the sixth, seventh, and eighth cervical, and the first, second, and third dorsal nerves.

We will now compare these facts with the results obtained by Ferrier and Yeo in their experiments on monkeys. In doing this we take the arrangement given in

their original communication,¹ for in the amended list² the small muscles of the hand are given as deriving their nervous supply through the second dorsal nerve, which is not the case in man. Thus the first list, in which the nerve-supply of each group of muscles was subsequently found to be one root too high, is the more useful for comparison. The relation between the two will be most clearly seen in the annexed table. On the left side are the muscles supplied by the various nerve-roots in the monkey, from the fourth cervical to the first dorsal. On the right a cross (+) is placed opposite each of the muscles which was affected in our case. Our notes of the condition of the muscles being not quite complete, the unaffected ones have been marked (-), whilst the condition of those muscles not marked was not ascertained.

Fourth cervical :

Deltoid	.	.	.	.	.	.	-
Rhomboids	.	.	.	.	.	.	-
Supra-spinatus	.	.	.	.	.	.	+
Infra-spinatus	.	.	.	.	.	.	+
Biceps	.	.	.	.	.	.	-
Brachialis anticus	.	.	.	.	.	.	-
Supinator longus	.	.	.	.	.	.	-
Extensors of wrist and fingers	.	.	.	.	.	.	+
Diaphragm	.	.	.	.	.	.	.

Fifth cervical :

Deltoid (clavicular part)	.	.	.	.	.	.	-
Biceps	.	.	.	.	.	.	-
Brachialis anticus	.	.	.	.	.	.	-
Serratus magnus	.	.	.	.	.	.	+
Supinator longus	.	.	.	.	.	.	-
Extensors of wrist and fingers	.	.	.	.	.	.	+

Sixth cervical :

Latissimus dorsi	.	.	.	.	.	.	+
Pectoralis major, sternal and costal	.	.	.	.	.	.	+
„ „ clavicular	.	.	.	.	.	.	-
Serratus magnus	.	.	.	.	.	.	+
Pronators (flexors of wrist)	.	.	.	.	.	.	.
Triceps	.	.	.	.	.	.	+

¹ 'Proc. Roy. Soc.,' 1881, vol. xxxii, p. 12.

² Ibid., 1883, vol. xxxv, p. 229.

Seventh cervical :

Teres major	.	.	.	.	.	.
Latissimus dorsi	.	.	.	.	.	+
Subscapularis	.	.	.	.	.	.
Pectoralis major, sternal and costal	.	.	.	.	.	+
" " clavicular	.	.	.	.	.	-
Flexors of wrist and fingers	.	.	.	.	.	+
Triceps	.	.	.	.	.	+

Eighth cervical :

Long flexors	.	.	.	.	.	+
Ulnar flexors of wrist	.	.	.	.	.	+
Small muscles of hand	.	.	.	.	.	+
Extensors of wrist and fingers	.	.	.	.	.	+
Triceps (long head)	.	.	.	.	.	+

First dorsal :

Small muscles of hand	.	.	.	.	.	+
Intercostals	.	.	.	.	.	+

From this table we see that, as far as the nerve-roots involved in the lesion—the sixth, seventh, and eighth cervical and the first dorsal—are concerned, the muscles affected in our case are those which Ferrier and Yeo found to be innervated by these roots. The clavicular fibres of the pectoralis major form an exception which will be considered later. When, however, we consider the fourth and fifth cervical roots, neither of which was involved in the lesion, we find that several muscles were affected which would have escaped had the lesion occurred in the monkey. These muscles are the serratus magnus, the extensors of the wrist and fingers, and the supra- and infra-spinatus. The *serratus magnus* in the monkey receives its nerve-supply from the fifth and sixth roots. In our case the marked atrophy of this muscle indicates that the fifth root took at the most but an unimportant share in its innervation. The *extensors of the wrist and fingers* were affected, and thus were supplied by a lower root than in the monkey. This agrees with Dr. Gowers's opinion¹ that in man these muscles are supplied by the sixth and seventh cervical roots.

The *supra-spinatus* and *infra-spinatus* appear to be

¹ 'Diseases of the Nervous System,' vol. i, p. 129.

usually supplied by the same root as the other muscles of the group which is generally affected in Erb's "upper arm type" of paralysis, viz. deltoid, biceps, brachialis anticus, and supinators.

Erb considered that paralysis of this group of muscles indicated affection of the sixth cervical nerve-root. Here, however, the supra-spinatus and infra-spinatus were the only muscles of the group supplied by this root, the others being supplied by the fifth or the fourth and fifth together.

Dr. Herringham¹ found from his dissections that the sixth "exercises sometimes an extremely small influence and sometimes none at all over the supra-spinatus and infra-spinatus." According to these observations the nervous supply of these two muscles was exceptional in this case.

The condition of the *pectoralis major* is one of the most interesting points to be considered. In Ferrier and Yeo's list the pectoralis major is given as supplied by the sixth and seventh roots. In our case the atrophied condition of the sternal and costal fibres of the muscle would agree with their innervation from these roots. The clavicular fibres were, however, evidently supplied by a higher root than the sixth, as they were unaffected. We have thus a clear illustration of the double nerve-supply of the pectoralis major. Attention was first drawn to this separate origin of the nerve-supply of the clavicular portion of the pectoralis major by Dr. Beever,² and was illustrated by some cases shown at this Society. Dr. Beever said, "I certainly think that the pectoralis major may have its two halves assigned to different parts of the cord, the clavicular half going along with the anterior fibres of the deltoid, of which it is a continuation, whilst the sternal half is more associated with the triceps group. This grouping is also illustrated by physiological action, for in pressing the two hands together the clavicular part

¹ 'Proc. Roy. Soc.,' 1886, vol. xli, p. 425.

² 'Med.-Chir. Trans.,' 1885.

of the pectoralis major, the anterior fibres of the deltoid, and the biceps are associated; whilst in pressing the hands downwards against a table the sternal part of the pectoralis major and the triceps act together, the biceps not being used in the movement, which may be illustrated by pressing on the table to assist in rising from a chair." These conclusions receive strong confirmation from the facts observed in our case.

The presence of the tracts of ascending degeneration in the posterior columns of the cord shows that the posterior roots of some of the nerves in the lower cervical and upper dorsal regions must have been compressed by the growth, although at the autopsy it was thought that they were not affected by it. Thus we are unfortunately unable to state from which posterior roots the degenerated fibres came. The posterior roots must have been affected to a much less degree than the anterior, for there was no anæsthesia, and the degeneration is not well marked.

The course taken by the degenerated tract is the same as that which is usually taken by the fibres which enter the cord in the "median bundle" of the posterior roots in the upper dorsal and lower cervical regions.¹

Similar ascending degeneration was observed by Dr. Howard Tooth² in his monkey No. 3, in which Mr. Horsley had divided the posterior roots of the sixth, seventh, and eight cervical and first dorsal nerves, and also in monkey No. 11, in which the left posterior roots of these same nerves and the second dorsal had been divided. In Dr. Tooth's monkey, however, there was also degeneration of the direct cerebellar tract, which was not affected in our case.

Apart from the above considerations the case is of interest as an example of a very wide dissemination of secondary growths in a case of carcinoma.

There can be little room for doubt that the growth in

¹ Foster, 'Text-book of Physiology,' pp. 891—893.

² Gulstonian Lectures, 'Brit. Med. Journ.,' April 20th, 1889.

the breast must be looked upon as the primary one. The growth here was solitary, and the minute structure was that of a glandular carcinoma of the type most commonly arising in the mammary gland tissue; whereas in any of the other situations in which, according to our present knowledge, such a growth could have arisen, the growths were multiple. In a table of 128 cases of general dissemination, compiled by Gross¹ from various sources, in which post-mortem examinations were made, the organs affected in our case were the seat of secondary growths in the following percentage:—axillary glands 89·94, other glands 23·43, bones 7·02, brain 2·34, kidney 3·9, adrenals 1·56, ovary 5·46, and intestine 0·78. The thyroid gland is not mentioned in his list. It is noteworthy that the liver, which is so frequently the seat of secondary deposits in cases of cancer of the breast, had in our case entirely escaped. In cases of carcinoma of the breast the ovaries are perhaps especially liable to be the seat of secondary deposits. Thus Stephen Paget,² in an analysis of 735 cases, found one or both ovaries affected in 37, “twice as often as the spleen, and as often as the spleen and kidneys put together.”

The remarkable uniformity of structure presented by the growths in such a case as this is one of the most powerful arguments in favour of the commonly accepted view that we have to deal with a single primary growth sowing itself by the lymph- and blood-streams in various parts of the body, and as strongly opposed to any theory which would endeavour to explain such a case by a widespread tendency of the tissues to the development of carcinoma. It is often interesting to note that the exact relations of such secondary nodules serve to distinguish them from a primary growth in the same position. Thus, in the case of the nodule in the end of the vermiform appendix, the mucous membrane was not invaded by the growth, which appeared to have commenced as a subserous

¹ ‘*Tumours of the Mammary Gland*,’ 1880, p. 161.

² ‘*Lancet*,’ 1889, vol. i, p. 571.

deposit. From it as a fresh centre the lymphatic glands in the lower end of the mesentery had become infected.

We have very scanty knowledge concerning the conditions which influence the position of the secondary deposits of carcinoma. In our case there was a remarkable tendency to bilateral symmetry in their arrangement ; thus both kidneys, both adrenals, and both ovaries were affected, whilst in the brain this same tendency was shown to a still greater degree.

(For report of the discussion on this paper, see 'Proceedings of the Royal Medical and Chirurgical Society,' Third Series, vol. iv, p. 3.)