

# B R A I N .

PART, IV. 1893.

## Original Articles.

### ON A CASE OF DESCENDING DEGENERATION OF THE LEMNISCUS, CONSEQUENT ON A LESION OF THE CEREBRUM.

BY ALEXANDER BRUCE, M.A., M.D., F.R.C.P.E.

*Assistant Physician to the Royal Edinburgh Infirmary.*

IN spite of the fact that within the last two decades considerable attention has been devoted to the course and connections of the complicated system, or systems, of fibres which are included together under the term *fillet*, or *lemniscus*, and that much has been settled by the study of its development as well as of its degeneration consequent on pathological and experimental lesions, many important points still remain obscure. The records of pathological degenerations are not only very few in number, but, with one or two exceptions, so wanting in details as to the minuter relations, that I am induced to describe the appearances in the medulla, found in a case which I have recently examined, and which seem to throw light on some of the inferior connections of the lemniscus.

The brain from which the specimen was obtained was sent me by my friend, Dr. Ruxton, of Wadsley Asylum, with the note that it had been obtained from an aged female lunatic, who had been for several years completely hemiplegic. The cause of the hemiplegia was an old hæmorrhage which had almost completely destroyed the basal ganglia and the internal capsule on the right

side, and had caused considerable atrophy of the centrum ovale and of the anterior two-thirds of the corpus callosum. The extent of the lesion may be seen in the drawing, fig. 30, plate xi., illustrating my paper on the absence of the corpus callosum in the human brain (*Brain*, 1889, p. 171).

The cerebrum was at that time examined principally with reference to certain points bearing on the results of the congenital absence of the corpus callosum; while the rest of the brain, including the crura cerebri, pons varolii, and medulla, was divided into transverse slices of less than one-quarter of an inch in thickness, and put aside for future investigation. Of these parts, only the medulla oblongata is now available; the other pieces having unfortunately been mislaid. With regard to them, however, it is certain that they contained no gross lesion such as could have given rise to the degeneration to be described. The medulla, which had been carefully hardened in Müller's fluid before reaching me, was embedded in celloidin and cut into thin transverse sections. These were stained by hæmatoxylin according to the Weigert-Pal method, and also by one-quarter per cent. watery solution of aniline blue-black, as recommended by Bevan Lewis.

In the sections which were stained by hæmatoxylin, the right anterior pyramid appeared completely degenerated. Its colour was pale yellow (with the exception of certain blue fibres, to be afterwards mentioned, which traversed it), and its size, as can be seen from the drawings, was greatly reduced. Staining by aniline blue-black showed that there was a slight increase of the connective tissue. In sections made slightly above the plane of the decussation of the anterior pyramid it was easily seen that this was not the only lesion. To elucidate the other degenerations four sections have been reproduced from drawings made with great care by means of Edinger's drawing apparatus in the first instance, into which the details were subsequently filled from the microscope.

Fig. 1 is drawn from a section at the lower extremity of the medulla, immediately above the plane of the decussation of the anterior pyramid, and therefore through almost the lowest fibres which enter into the fillet.

On the right side the compact bundle of internal arcuate fibres which arises from the nuclei of both divisions of the posterior columns of the cord is seen to pass forwards, in the normal manner, as a compact, somewhat arched bundle of fibres. This, after passing outside the ascending root of the glosso-pharyngeal nerve (seen as a small mass of transversely divided fibres), turns inward and crosses the mesial plane as the decussation of the fillet (D.F.) to insert itself between the antero-lateral ground bundles (A.L.G.B.), and the anterior pyramid. (The distance to which these fillet fibres pass outwards between the two last-mentioned systems should be noted.)

On the left side these arcuate fibres are very few in number, and, at first, do not attract the eye. Those that are here present seem to be of finer calibre than those on the other side. This may, perhaps, be owing to the fact that they are few in number and separate from each other. They almost all enter the nucleus cuneatus (N.C.); of hardly any can it be said definitely that they join the nucleus gracilis (N.G.). After crossing the mesial plane at D.F. they appear between antero-lateral basis bundles and the degenerated anterior pyramid (Pyr.), with the exception of a few fibres which pass as anterior external arcuate fibres (F.A.E.A.) round the inner and ventral aspect of the pyramid (the course of which will be referred to below). Both the nucleus gracilis and the nucleus cuneatus on the left side are very considerably less than the corresponding nuclei on the right side. At this level I think that the nucleus gracilis has atrophied to a rather greater degree than has the cuneate nucleus.

The two divisions of the posterior columns seem to present a normal appearance on both sides, as also do all the other structures, with the exception, already mentioned, of the pyramids (Pyr.). There was no detectable difference in the size of the ascending roots of the 5th nerve, the substantiæ gelatinosæ (S.G.), the direct cerebellar tracts (D.C.T.), the antero-lateral ground bundles (A.L.G.B.), or the anterior external arcuate fibres (F.A.E.A.). The asymmetry of the two sides of the section is due to the shrinkage of the degenerated right anterior pyramid, and of the lower end of the fillet, which has disappeared from the spot immediately behind it.

Fig. 2 is drawn from a section made through the lower extremity of the inferior olive. On the right side, the nucleus gracilis and nucleus cuneatus are of normal size. The median internal arcuate fibres (F.A.I.M.), which emerge from these, pass forwards and inwards in curves with their convexity outwards. They may be almost divided into two groups, a posterior and an anterior. The posterior group forms a bundle of fibres nearly as compact as in fig. 1. Some of these pass close round the inner side of the ascending root of the glosso-pharyngeal nerve (and indeed seem to arise from it). This group of fibres passes through the more posterior fibres of the posterior longitudinal fasciculus, crosses the raphe at a somewhat acute angle, and passes forwards and slightly outwards. The second or anterior group of these internal arcuate fibres passes forward through the formatio reticularis in more open curves of somewhat widely separated fibres, which cross the raphe and enter the fillet (or inter-olivary stratum) of the opposite side.

On the left side the two nuclei of the posterior columns are atrophied, apparently to nearly equal degree (though on the whole, I think that the nucleus gracilis is the more affected). The fine felt work of fibres within these nuclei has to a large extent disappeared, so that their colour in hæmatoxylin sections is decidedly paler than those on the right side. The median internal arcuate fibres have almost entirely disappeared from this side. Those which pass to the inner side of the ascending root of the glosso-pharyngeal nerve have all but entirely gone. Of the others, a small number of separate (and fine) fibres arch along the dorsal part of the formatio reticularis, and cross the posterior longitudinal fasciculus to enter the inter-olivary stratum of the opposite side. The comparison of the formatio reticularis in the intermediate field of Flechsig on the two sides is most striking. On the right the arcuate fibres form a distinct tract, which catches the eye at once, on the left there remain but a few fibres which require a careful search to be seen. The contrast between the two sides of Flechsig's inner field, viz., that between the raphe and the root of the hypoglossal nerve (not figured) is no less striking, though perhaps not quite so much so as in figs. 3 and 4. The strip of transversely divided fibres which extends

along the right side of the raphe from the hypoglossal nucleus to the degenerated anterior pyramid is greatly reduced in size. This change is most marked anteriorly, where the fibres become attenuated to a narrow point (Fill.) which projects into a pale V-shaped area, the outer limit of the V being the internal accessory olive; and the inner, the area from which the degenerated fibres of the fillet have disappeared. The most dorsally situated fibres in the area form a band considerably less broad than the corresponding ones on the other side. The anterior external arcuate fibres which are seen to arise from the fillet, pass, partly as a small strand between the inferior olive and the degenerated pyramid, partly round the inner and anterior aspects of the pyramid, at the outer side of which it joins the first strand. A third series passes as scattered fibres into the pyramid. I have been unable to detect any diminution in the number of any of these three strands of external arcuate fibres on careful comparison of the two sides. Beyond the asymmetry of the medulla, which results from the above-mentioned degenerations, no other abnormality could be seen in the section.

Fig. 3 represents a plane of section very slightly higher than that of fig. 2, but still through the lower end of the olive. The asymmetry of the two sides of the section is as marked as in fig. 2, and its cause is the same. The all but complete disappearance of the internal arcuate fibres on the left side is as marked as in fig. 2. Those fibres which remain are fine and separate from each other. They lie almost entirely in the posterior part of the *formatio reticularis*, and terminate mainly in the internal cuneate nucleus, but also partly in the nucleus *gracilis*. The cuneate nucleus appears in this section to show a relatively rather higher degree of atrophy than does the nucleus *gracilis*. Both are much paler than normal, owing to the disappearance from their interior of the terminal twigs of the arcuate fibres. In Flechsig's inner field the contrast between the two sides is greater than in fig. 2. The fibres in this region which lie between the hypoglossal nucleus and the anterior pyramid are usually divided into two pretty nearly equal parts, a line drawn between the two dorsal ends of the internal accessory olive forming the supposed boundary line. The portion of fibres behind this

imaginary line is usually regarded as the posterior longitudinal fasciculus, that anterior to it as the fillet (or inter-olivary stratum). Both these strands are reduced in breadth, but to different degrees. The posterior half is about one-half the width, the anterior is about one-eighth or less, being fined away to a narrow point anteriorly, so that the internal accessory olive comes almost to touch the raphe. A fine pale line is seen along the outer side of both halves of the strand, showing where the degenerated fibres have fallen out. The hypoglossal nerve on the right side has approached the raphe considerably, being only about half as far from it as the left nerve.

The external anterior arcuate fibres which lie in front of and behind the right anterior pyramid, are in no way fewer than those of the opposite side. The section was otherwise perfectly normal.

Fig. 4 was drawn from a section made slightly above the middle of the olive, and just above the upper end of the nucleus gracilis. On the left side those median internal arcuate fibres which pass from the cuneate nucleus behind the inferior olive, have almost entirely disappeared. A few can still be seen to enter the internal cuneate nucleus (N.C.I.), but those which, on the right side, pass in relation to, and as if arising from, the ascending root of the glosso-pharyngeal nerve (IX. Asc.) have entirely disappeared. On the right side all the median internal arcuate fibres are normal. The lateral internal arcuate fibres which pass from the left restiform body, partly through, partly behind, and partly in front of the olive, to end in the opposite olive, are equally present on the left as on the right side. The great contraction of the fibres in the whole extent of the inner field of Flechsig is very distinct, being marked off from the rest of the *formatio reticularis* by a narrow pale band, which widens out anteriorly, so that in the drawing it is difficult to distinguish it from the internal accessory olive. The posterior part, which corresponds to the posterior longitudinal fasciculus (P.L.F.), is, on the right side, only one-half the breadth of that on the left; while the inter-olivary stratum (Fill), is reduced to one-eighth of the breadth of the other. Those fillet fibres which are found between the internal accessory and the main olive, have also disappeared on the right side. The anterior external arcuate fibres (F.A.E.A.)

are quite normal on both sides. The two restiform bodies (C.R.) are quite equal, and the posterior external arcuate fibres (F.A.E.P.) are in no way diminished on the left side. There is no other abnormality in the section.

This case shows that, in consequence of a lesion destroying the basal ganglia and the internal capsule in the cerebrum, the fillet may degenerate in a descending direction, through the inner field of Flechsig in the same side of the medulla, through the median internal arcuate fibres of the opposite side, as far as the nuclei of the two divisions of the posterior columns of the cord.

The degeneration in the inner field is not co-extensive with what is usually regarded as the inter-olivary stratum. This name is given to those longitudinal fibres which are contained between the raphe and the inferior olive, and between the posterior surface of the medulla and an imaginary line joining the hinder limits of the two internal accessory olives.

The degeneration affects about seven-eighths of the fibres in this area, those fibres which remain intact forming a very narrow zone along the side of the raphe. But the degeneration also extends in a backward direction as a very narrow zone along the outer side of the posterior longitudinal fasciculus. From the examination of several other cases of degeneration in the medulla, I can find no evidence to show that these fibres do not belong to the fillet, and I am inclined to think, therefore, that the limits of the fillet are more extensive than developmental evidence would appear to show.

Those fibres which remain in the anterior part of the inner field are either part of the system of the posterior longitudinal fasciculus, or are fibres of the fillet which have escaped degeneration, either because they degenerate only in an upward direction, or, if they degenerate downwards, because they arise in the pons and corpora quadrigemina, from levels too far down to be affected by a lesion in the cerebrum. We shall see reason to believe that the latter is the case. It is possible that this may be the explanation, but it would be of great importance to compare this case with one where a descending degeneration had followed a pontal lesion, and where presumably both the cerebral and pontine fillets had been cut across. In Spitzka's case (*loc. cit.*) the whole

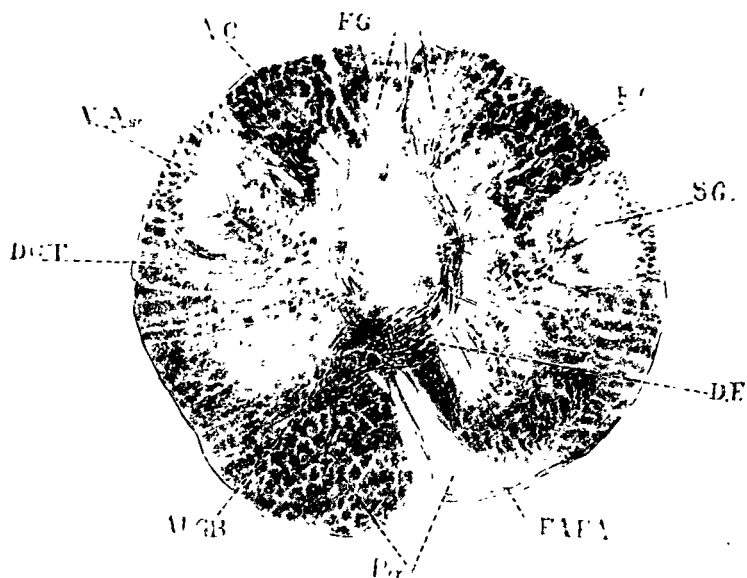
stratum would appear to have degenerated, but his figures are somewhat too small to enable one to form a definite opinion from them.

Certain of the internal arcuate fibres of the opposite side have disappeared. The lateral group which connects one olive with the opposite restiform body, are quite intact; but the great majority of the median arcuate fibres which are found in the lower part of the medulla have disappeared. A comparatively small number remains. These are seen as fine fibres, extending from the raphe along the most posterior part of the formatio reticularis, towards both nuclei of the posterior columns.

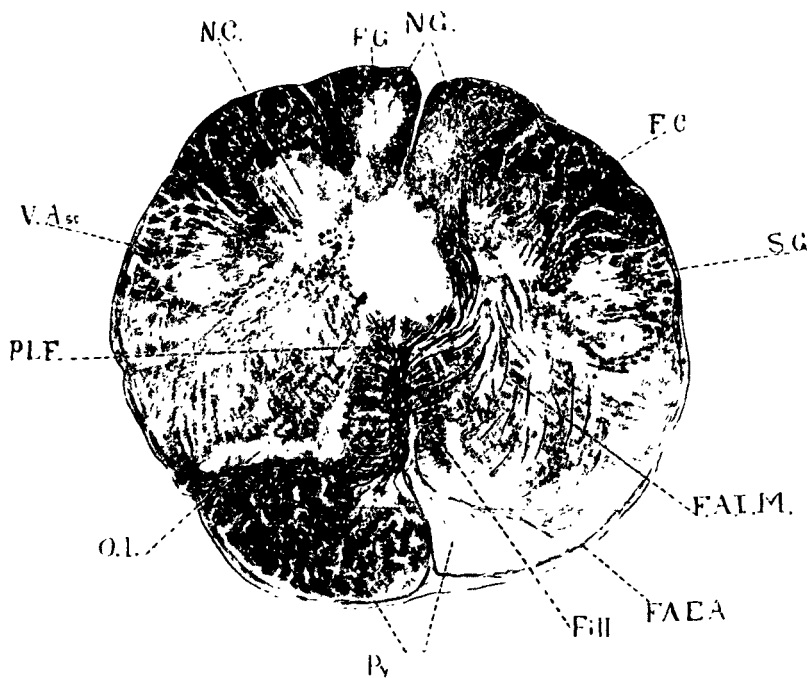
At the lower part of the medulla the number increases, till a compact bundle is formed, which can be traced pretty definitely for the most part from the undegenerated remnant of the opposite fillet into the nucleus cuneatus. It would appear from this, therefore, that the nucleus cuneatus is more directly connected, than is the nucleus gracilis, with those fibres of the fillet which end below the cerebrum. This is in harmony with the results obtained from the embryo (see Illustrations of Mid and Hind Brain, plate xiii., fig. 3, where it is seen that the earliest fibres of the fillet arise from the cuneate nucleus, and cannot be traced higher than the pons; see also reference to Bechterew's paper on the Fillet at page 37, which agrees with this view). It is certain, however, that all the persistent arcuate fibres do not arise from the fillet, but that a large number of them are directly continuous with the opposite anterior external arcuate fibres, which pass in undiminished numbers to the opposite restiform body, partly in front of, partly through, and partly behind the anterior pyramid. Hösel says that in his case they have entirely disappeared from within the pyramid. I have carefully compared my sections with others from a simple degeneration of the pyramid, and can find no difference in the numbers of undegenerated fibres within the pyramids in the two cases. It is possible that Hösel has over-estimated the number of these fibres in the sound side, as it is likely that the wavy appearance, noted by him as due to the passage of arcuate fibres through the pyramid, is largely the result of a re-arrangement of the pyramidal fibres, preparatory to their decussation. It should be noted also that

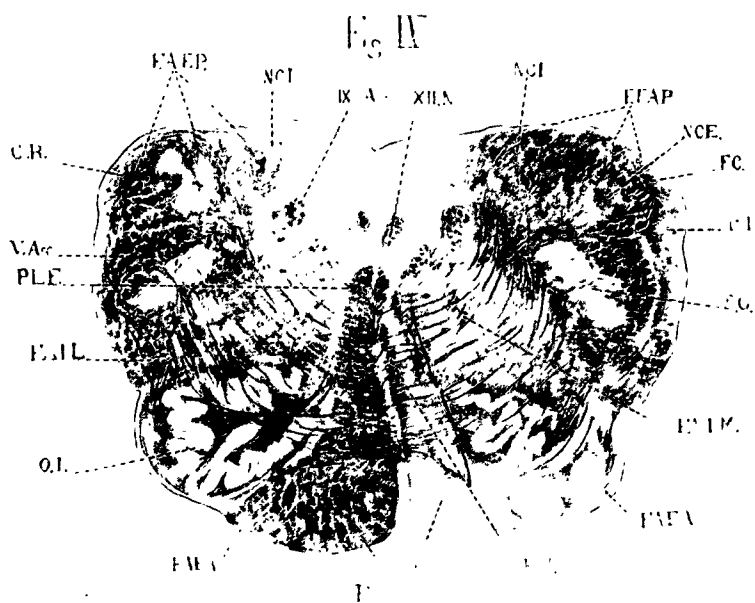
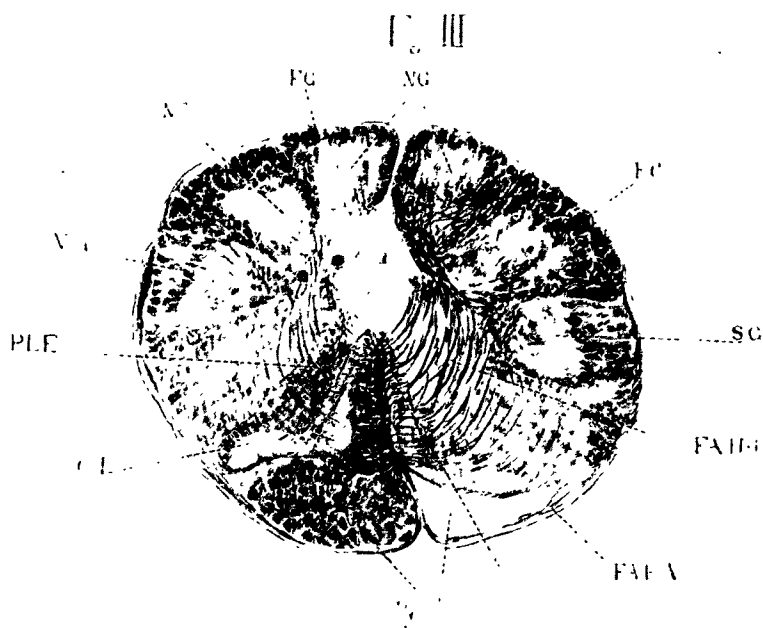


# F<sub>1</sub> I



# F<sub>3</sub> II





those internal arcuate fibres which pass from the inner side of the ascending root of the 9th nerve, have all but disappeared, while the nerve itself is quite normal. Through the kindness of Dr. Abernethy I have had the opportunity of comparing with this case one of degeneration of the ascending root of the 9th nerve, in which these arcuate fibres are intact. It is, therefore, certain that the ascending root of the glosso-pharyngeal nerve is not directly connected with the fillet.

Both nuclei of the posterior columns showed a considerable degree of atrophy on the left side. This was evidenced, in the hæmatoxylin section, by a decrease in the size of the nuclei, and a diminution of the network of fibres belonging to the internal arcuate system; and, in sections stained with aniline blue-black, by disappearance of the nerve cells and also by an increase of the connective tissue. At the lower extremity of the medulla, the nucleus gracilis seems to have atrophied to a greater degree than the nucleus cuneatus; but at levels opposite the upper extremity of the nucleus gracilis the internal cuneate nucleus seemed to have degenerated to an equal, if not to a greater, extent. These facts would appear to warrant the following conclusions as to the connections of the fillet: that the nucleus gracilis is the terminal point for the great majority of the fibres which pass upwards to the cerebrum, while the nucleus cuneatus, at its lower part, receives mainly fillet fibres from the pons, which have escaped degeneration, but, in its upper part, getting also fibres from the cortical fillet. Observers of the degeneration of the nuclei have obtained somewhat divergent results; Monakow finding in an experimental case that the nucleus gracilis was the more atrophied, while Déjérine, Flechsig, and Hösel found the greater change in the cuneate nucleus. Spitzka, in his case, where the lesion was in the pons, and where, presumably, all the fibres of the fillet were degenerated, found the nucleus gracilis the more affected. The external cuneate nuclei are unaffected, and are therefore, presumably, not end stations of the fillet at all.

It is remarkable that none of the other tracts connected with these two nuclei show any evidence of diminution in size. Both divisions of the posterior columns of the two sides are equal, so, too, are both sets of posterior and anterior external arcuate fibres.

It follows, therefore, either that there are in these nuclei still undegenerated cells, which are the trophic centres for these arcuate fibres, or else, that their trophic centre is situated in the cerebellum. My case does not enable one to draw any conclusion as to this, which can only be proved by a comparison of destructive lesions in the nuclei or in the middle lobe of the cerebellum, the two terminal points of these strands. It is known that the posterior columns do not degenerate downwards.

Unlike Hösel's case, no difference could be traced between the two 5th nerves.

The most important cases of descending degeneration from a cerebral lesion are those of Witkowski (*Arch. f. Psychiatrie*, Bd. xiv., p. 140); Déjérine (*Arch. de Physiol.*, 1890); Hösel (*Arch. f. Psychiatrie*, Bd. xxiv., p. 452); Monakow (*Neurol. Centralblatt*, 1885, p. 69). Spitzka, in the *Medical Record*, 1884, p. 393, describes carefully a descending degeneration from a lesion in the pons. Most of the other cases, which are fully referred to in Déjérine's and Hösel's papers, are too briefly described to be of much value.

The four figures are photogravures (by Messrs. Thevoz, of Geneva) of the original pencil drawings. Fig. IV. is reduced in scale ( $\frac{8}{11}$ ).

#### REFERENCES IN FIGURES.

- A L G B, antero-lateral ground bundles.
- C R, restiform bodies.
- D C T, direct cerebellar tracts.
- D F, decussation of fillet.
- F A E A, antero-external arcuate fibres.
- F A E P, postero-external arcuate fibres.
- F A I M, medio-internal arcuate fibres.
- F ill, fillet (not lettered in fig. 3).
- N C, nucleus cuneatus.
- N C I, internal cuneate nucleus.
- N G, nucleus gracilis.
- O I, inferior olive.
- P L F, postero-longitudinal fasciculus.
- Pyr, anterior pyramids.
- S G, substantia gelatinosa.
- V. Asc., IX. Asc., XII. N., v., ix. and xii. nerves.