THE NUCLEUS IN THE HUMAN RESTIFORM BODY*

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INTRODUCTION

So far as I know there is no literature on the subject of the nucleus in the restiform body. As I found a small nucleus in the restiform body while studying the human brain, the thought occurred to me that the nucleus would probably be constant in the human restiform body, and led me to undertake the examination of many other human brains. At first I doubted whether this could be demonstrated. But minute examinations revealed that a nucleus was constantly found in the restiform body of all human brains. The details of the nuclei in these cases are as follows.

REPORT OF CASES

All brains were fixed in formaldehyd solution and cut so as to obtain transverse sections 25 microns in thickness, in series, from the medulla oblongata and pons; then the sections were stained by the Nissl method and examined from beneath under the microscope.

Case I.

As a series of successive transverse sections through the medulla oblongata is studied, it will be noticed that there is a little mass of gray matter in the restiform body, which first comes into sight in the section where the inferior olive is marked and the superior vago-glossopharyngeal roots are still seen, and lies a little dorsomedially from the middle of the transection

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of the restiform body. This mass is composed of the nerve-cells and stroma which takes a deep staining by thionin. Higher up, the nerve-cells increase in number and accordingly various changes occur in the form of the nucleus. This nucleus presents a small round outline at the beginning. Soon it becomes a little bent, its concavity pointing in the dorsomedial direction, and then clearly defined dorsal and ventral roots develop. As the size of the nucleus increases, the ventral root becomes longer than the dorsal and its point begins to bend ventrally. Thus the nucleus shows an open mouth which might be called the hilum, and presents itself as a succiform outline (Figs. 1 and 2). The dorsal root likewise bigins to bend it's point dorsally, both roots finally becoming nearly the same in length and the opening gradually widening. Now the whole nucleus assumes the form of the letter U. Still higher up, as the hilum opens wider and the angle between both roots becomes larger, with the exception of a slight curve of the ventral root, the points of neither are no longer bent. The nucleus has been gradually increased in size and shows, in this part, it's greatest transection, it's hilum medially pointing towards the median raphe simply. Again higher up, when the inferior portion of the accessory anditory nucleus appears, the nucleus begins to decrease in size and shortly afterwards, assuming it's original round form, disappears.

Fig. 5 shows the configurations of the nucleus in the restiform body in transverse sections at various heights in this case, which are arranged in a systematic order from below upwards. The nerve-cells of the nucleus, for the most part, incline to become round, but in some instances they are somewhat fusiform (Fig. 3), approximately of the same size, averaging from 11.1 to 22.2 microns, the longitudinal diameter (the distance between the superior and inferior ends) of the nucleus measuring about 1.3 m. m.

Case II.

In this case the nucleus in the restiform body both as to height in the medulla oblongata in the beginning of it's inferior end and also it's situation

in the restiform body, is nearly the same as in the first case.

The nucleus, however, is smaller and without the peculiar hilum. In transverse sections the nucleus appears as a small round or transversely elliptical mass. But by the close examinations, we see that there are a very few nerve-cells in the lateral part of the nucleus which appears as a slightly elongated mass in the section. That makes one think that it may be an imperfect hilum. The superior end of the nucleus disappears before the accessory auditory nucleus appears in the section.

Fig. 6 shows the configurations of the nucleus in the restiform body in transverse sections at various heights in this case, which are arranged regularly from below upwards. The state of each nerve-cell of the nuclei differs little in the first and second cases, the average size of the nerve-cells of the nucleus measuring from 7.4 to 18.5 microns and the longitudinal diameter of the nucleus about 0.6 m. m.

Case III.

In this case the nucleus in the restiform body is also undergrown and not eminent as in the first case. But the height in the medulla oblongata in the beginning of it's inferior end and it's situation in the restiform body are the same as in the previous case, being a small round mass in the beginning of it's appearance. It gradually increases in size and then shows an elongated shape extending from the dorsomedial towards the ventrolateral. When the nucleus shows it's greatest development, there is a constriction in the middle, dividing the nucleus into two parts, the dorsal and ventral, the dorsal gradually disappearing while the ventral increases. The ventral, too, after assuming an elongated form and finally a small round mass, disappears. The superior end of the nucleus disappears before the accessory auditory nucleus appears in the section.

Fig. 7 shows the configurations of the nucleus in the restiform body in transverse sections at various heights in this case, which are arranged regularly from below upwards. There is no great difference between the third

and previous cases in the characteristics of each nerve-cell of the nuclei, the average size of the nerve-cells of the nucleus measuring from 7.4 to 22.2 microns and the longitudinal diameter of the nucleus about 0.9 m. m.

Case IV.

In this case the growth of the nucleus in the restiform body is very poor and it exhibits only it's traces. But the height in the medulla oblongata in the beginning of it's inferior end and it's situation in the restiform body are the same as in the previous case.

The form of the nucleus in transverse sections presents itself generally as only a small and round mass. Nevertheless, the nucleus is a little long in form in the section, when it shows it's greatest development near the middle of it's whole body, and it's long axis runs from the dorsomedial direction towards the ventrolateral. No hilum, however, can be seen in the nucleus. The superior end of the nucleus disappears nearly in the same manner as in the previous case.

Fig. 8 shows the configurations of the nucleus in the restiform body in transverse sections at various heights in this case, which are arranged regularly from below upwards. There is no great difference between the fourth and previous cases in the state of each nerve-cell of the nuclei, the average size of the nerve-cells of the nucleus measuring from 11.1 to 18.5 microns and the longitudinal diameter of the nucleus about 0.6 m. m.

Case V.

In this case the growth of the nucleus is also very poor and shows it's traces on sections. But the height in the medulla oblongata in the beginning of it's inferior end and it's situation in the restiform body are the same as in the previous case.

The nucleus is round in shape in transverse sections and varies a little in form, showing it's greatest growth in the middle section. The nucleus disappears showing no trace of the hilum in any part and becomes smaller

gradually. It's nerve-cells are very few in number. The superior end of the nucleus lies nearly in the same height in the medulla oblongata, as in the previous case.

Fig. 9 shows the configurations of the nucleus in the restiform body in transverse sections at various heights in this case, which are arranged regularly from below upwards. There is no great difference between the fifth and previous cases in the state of each nerve-cell of the nuclei, the average size of the nerve-cells of the nucleus measuring from 11.1 to 25.9 microns and the longitudinal diameter of the nucleus about 0.5 m. m.

Case VI.

In this case the growth of the nucleus is also very poor, but the height in the medulla oblongata in the beginning of it's inferior and superior ends, and it's situation in the restiform body are the same as in the previous case.

The nucleus also shows a small round mass in the section in the beginning, afterwards changing into a little elongated mass with the long axis which runs from the dorsomedial direction towards the ventrolateral, when the nucleus attains it's maximum size near the middle. At the superior end of the nucleus, a small round mass appears in the section just as in the beginning. The nerve-cells of the nucleus are also very few in number.

Fig. 10 shows the configurations of the nucleus in the restiform body in transverse sections at various heights in this case, which are arranged in a systematic order from below upwards. There is no great difference in the state of each nerve-cell of the nuclei between the sixth and previous cases, the average size of the nerve-cells of the nucleus measuring from 11.1 to 22.2 microns and the longitudinal diameter of the nucleus about 0.6 m. m.

Case VII.

In this case the nucleus has not reached an advanced stage of development, but it is nearly the same in height in the positions of it's inferior and superior ends in the medulla oblongata, and also in nearly the same situ-

ation in the restiform body, as in the first case.

The nucleus appears as a small round mass in the section in the beginning. Then it becomes a slightly elongated mass with the long axis which runs from the dorsomedial direction towards the ventrolateral, when the nucleus has reached it's maximum stage of development, nearly in the middle, exactly in the same manner as in the previous case. At the same time we see that the dorsolateral part of the nucleus abounds in nerve-cells and accordingly the ventromedial part of the nucleus presents a very incomplete hilum. Higher up, the nucleus disappears after becoming a small round mass as in the previous case.

Fig. 11 shows the configurations of the nucleus in the restiform body in transverse sections at various heights in this case, arranged in a systematic order from below upwards. There is no great difference in the state of each nerve-cell of the nuclei between the seventh and previous cases, the average size of the nerve-cells of the nucleus measuring from 11.1 to 25.9 microns and the longitudinal diameter of the nucleus about 0.8 m. m.

Case VIII.

In this case the growth of the nucleus is in a low state of development, but is of nearly the same height in the medulla oblongata in the beginning of it's inferior end and also in nearly the same situation in the restiform body as in the previous case. The superior end of the nucleus disappears when the accessory auditory nucleus begins to appear.

The nucleus appears as a small round mass in the section in the beginning; but when it is most developed it shows a slight curvature nearly in the middle, and a very indistinct and incomplete hilum.

Fig. 12 shows the configurations of the nucleus in the restiform body in transverse sections at various heights in this case, which are arranged in a systematic order from below upwards. There is also no great difference in the state of each nerve-cell of the nuclei between the eighth and previous cases, the average size of the nerve-cells of the nucleus measuring from 11.1

to 18.5 microns and the longitudinal diameter of the nucleus about 0.6 m. m.

In addition to the foregoing cases, the brains of one adult and one fetus stained by the Nissl method and those of three adults stained by the Weigert method were examined. But the states which are found in the Nissl sections are not described in detail here, since some sections were not well stained and some not made in good series. A small nucleus, however, was found always in the restiform body of each of these cases. It is nearly the same in form with the previous cases and takes nearly the same position with them in the restiform body. This is the same for the specimens which were stained by the Weigert method. All show a small peculiar nucleus in their restiform bodies in the same manner, as in the previous cases. In this way, there is a small nucleus in the restiform body in all cases. But the growth and forms of the nuclei are greatly different in cases and there is no nucleus in them which shows a marked hilum as in the first case, though some are slightly curved in transverse sections and show a very incomplete hilum in the nucleus. It is necessary to pay attention to the fact that the long axis of the nucleus on transverse sections always runs from the dorsomedial direction towards the ventrolateral, when the nucleus appears as a long mass in the section. It is clearly seen in the Weigert sections that a dense crowd of the nerve-fibres streams into and out of the hilum and also surrounds it. But there is no evidence as to the origin of these nerve-fibres. A description of the state of the nuclei in the restiform bodies which were found in the preparations stained by the Weigert method is omitted in this paper, since the nerve-cells of the nuclei are not naturally well shown by this staining.

DISCUSSION

Thirteen human brains, in all, were examined. The nuclei in the restiform bodies in eight of them were described in detail previously. They show all the brains of the adults of both sexes except the eighth case which shows that of a fetus with the length of 44.5 c. m. The remaining

five cases consist of four adults and one fetus as already mentioned. In all of these cases, it is found that a peculiar nucleus exists at the dorsomedial part of the restiform dody in transverse sections. From what has been said it will be seen that the peculiar nucleus in the human restiform body develops even in the embryonic period and it remains in the adults of both sexes. The inferior end of the nucleus begins in the restiform body, when the superior vago-glossopharyngeal roots appear in the section, and it's superior end disappears when or after the accessory auditory nucleus appears. Therefore, the longitudinal axis, the distance between the upper and lower ends of the nucleus is very short, but it's transverse axis is shorter still. Consequently, the nucleus is a small long mass of gray matter extending longitudinally, the average length of it's longitudinal axis measuring from 0.5 to 1.3 m. m.

The nucleus shows a hilum directing towards the medial direction, when it is well developed as in the first case. It is, however, mostly in an undeveloped stage, and simply shows a small roundish or elliptical mass in the sections. Even in such a case, the nucleus not rarely shows the traces of the hilum in transverse sections. The following are the properties common to all.

(1) The situation of the nucleus in the restiform body is the same in all cases.

(2) The long axis of the nucleus runs always from the dorsomedial direction towards the ventrolateral in the sections when the nucleus is elongated in transverse sections.

(3) The nucleus becomes curved and shows an incomplete hilum in it in the sections, when the nucleus is elongated in transverse sections.

(4) The shapes of the nerve-cells of the nuclei are the same in all cases.

The forms of the nerve-cells of the nucleus seem nearly the same with those of the inferior olive. They are roundish or somewhat elliptical in form and nearly the same in size with each other, the average size of the nerve-cells measuring from 7.4 to 25.9 microns. The nerve-cells are pretty uni-

formly scattered in the gray matter. They are, however, sometimes particularly crowded in the periphery of the gray matter or more rarely a very few nerve-cells exist out of the gray matter, but placed very close to it.

The brains of some other mammals viz. the monkey, dog, cat, rabbit and guinea pig were examined under the supposition that such a nucleus as that found in the human restiform body also might be found in their restiform bodies. But the thorough examinations entirely failed to find it in these specimens. Therefore it is probable that the nucleus of this kind is characteristic to the human kind.

The physiology of the nucleus and it's relations to the other parts of the brain are entirely unknown. It is very interesting to see that the nucleus is found always only in the human kind which shows the greatest development of the inferior olive, but not in the animals as mentioned above which show very slight development of the inferior olive. This suggests that the nucleus in the restiform body may be a portion of the inferior olive, which has found it's way into the restiform body. It is not inconceivable from the following points:

(1) That the nucleus presents itself in the restiform body when the inferior olive shows it's greatest development.

(2) That the nucleus has a hilum in it in some cases and it bears some resemblance to a part of the inferior olive.

(3) That the nerve-cells of the nucleus bear a striking resemblance in shape to those of the inferior olive (Figs. 3 and 4).

(4) That there is the fact that the restiform body and inferior olive have a very intimate relation.

(5) That the fact that the nucleus mostly shows it's traces and a considerable amount of variation in shape and development in all cases makes one think that the nucleus may be a phylogenetically young one first built in the human kind which shows the greatest development of the restiform body and inferior olive.

The above is, of course, nothing but a supposition. Simply, judging

from the morphological states of the nucleus, however, it is a proper hypothesis.

CONCLUTIONS

(1) There is a nucleus in the human restiform body.
(2) Tracing the transverse sections from below upwards, the nucleus appears on the section nearly when the vago-glossopharyngeal roots begins to disappear, and disappears nearly when the accessory auditory nucleus begins to appear.
(3) The nucleus exists at the dorsomedial part of the restiform body on transverse sections and extends in an elongated shape in the medulla oblongata.
(4) The nucleus has no definite shape and shows a considerable amount of variation in growth. On transverse sections, the transections are different in form. Some have a hilum tending towards the medial direction while the others present themselves as long masses extending from the dorsomedial direction to the ventrolateral, some of which also show the incomplete hilum-like parts in them, and further the others show only round masses.
(5) The nerve-cells of the nucleus are the same in shape with those of the inferior olive.
(6) The nucleus is probably a portion of the inferior olive.

It is a great pleasure to acknowledge my indebtedness to Dr. K. Kosaka for his kind advice and excellent facilities afforded to me.

EXPLANATION OF FIGURES

Fig. 1.—Transverse section through the middle of the inferior olivary region of the human medulla oblongata (Section No. 169).

No.	Inferior olive.
X, IX.	Vago-glossopharyngeal roots.
Crst.	Restiform body.
x.	Nucleus in restiform body.

Fig. 2.—Nucleus in the restiform body in Fig. 1, magnified.
Fig. 3.—Nerve-cells of the nucleus in the restiform body in Fig. 1, magnified powerfully.
Fig. 4.—Nerve-cells of the inferior olive in Fig. 1, that is the part in the square, in the same magnification with the former.
Fig. 5–12.—The shapes of the nuclei in the restiform bodies on transverse sections, in cases I to VIII inclusive, which are arranged systematically from below upwards.

Fig. 1

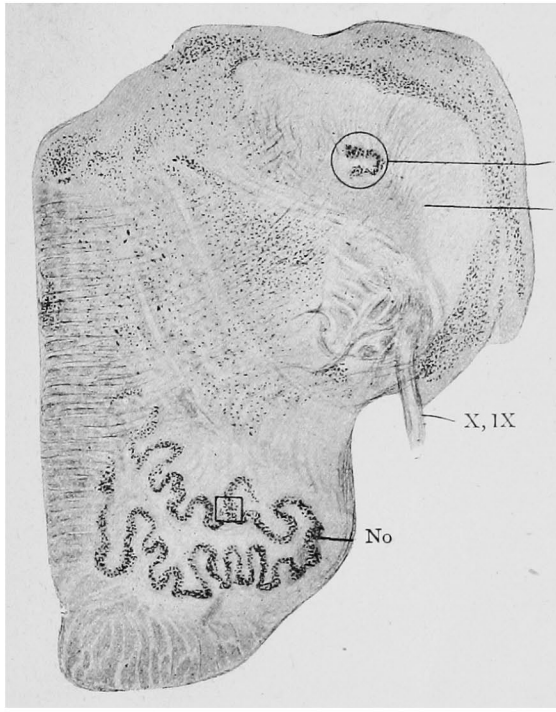

Fig. 2

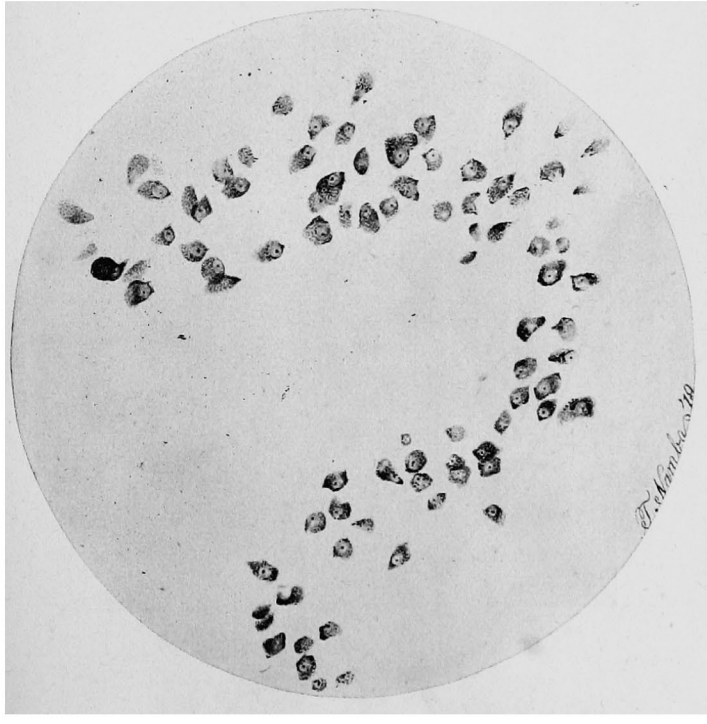

Fig. 3

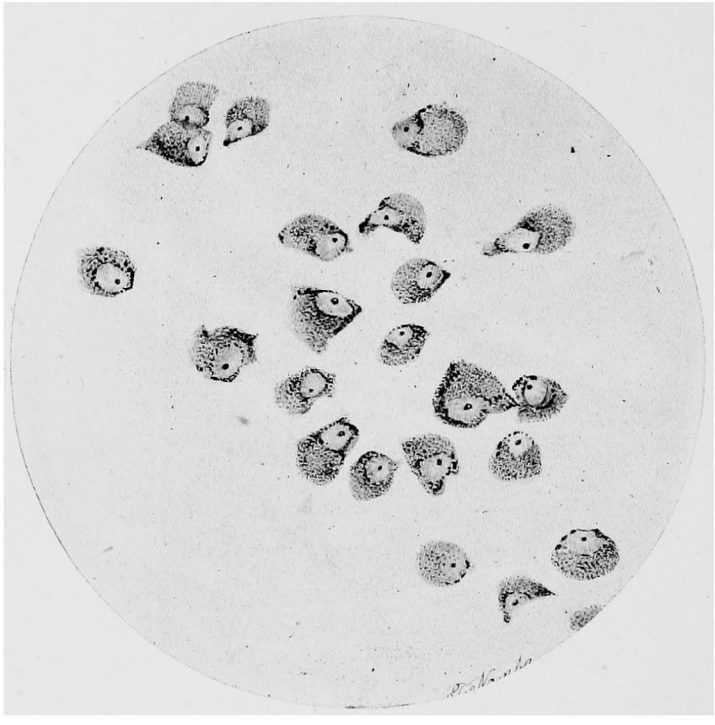

Fig. 4

Fig. 5

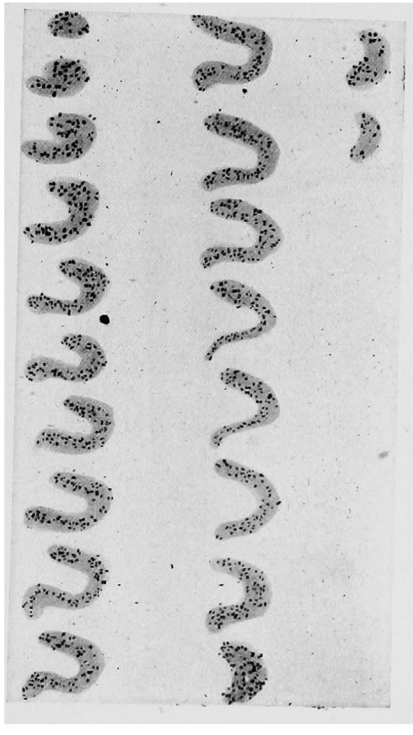

Fig. 6

Fig. 7

Fig. 8

Fig. 9

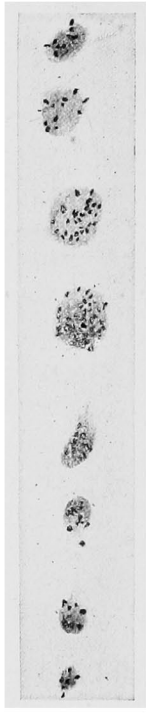

Fig. 10

Fig. 11

Fig. 12