Rev. Odont. UNESP
11(1/2):13-25, 1982

COMPARATIVE STUDY OF THE MEDULLA OBLONGATA, PONS, MESENCEPHALON AND CEREBELLUM OF THE TUFTED CAPUCHIN, *Cebus apella* LINNAEUS, 1758.

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ABSTRACT: Macro and microscopical aspects of the medulla oblongata, pons, mesencephalon and cerebellum of the Cebus apella were studied in ten encephalons of adult monkeys. The observations allow to conclude that: the brain stem of the Cebus apella *seems to be more developed than the one of the* Callithrix. *The medulla is very well marked; the pyramids, their decussation and the olivers are more evident in* Cebus apella than in Callithrix, *but they are less evident than in man. The pons is conspicuous as well as the trigeminal nerve and the medial cerebellar peduncle. On the mesencephalon the colliculi are prominent and cerebral peduncles resemble more the human; the IV ventricule morphology shows to be closer to the man's one than that from the* Callithrix jacchus. *The cerebellum of the* Cebus *is much more developed than the one of the* Callithrix. *Fissures and folia resemble the human cerebellum, although they are much simpler; the following cell groups and main fiber bundles were identified in the* Cebus *brain stem: fasciculus and nucleus gracilis; fasciculus and nucleus cuneatus; nucleus cuneatus accessorius; fasciculus pyramidalis; decussatio pyramidum; nuclei olivaris; nucleus spinalis nervi trigemini, fasciculus longitudinalis medialis; penduculus cerebellaris caudalis medialis and cranialis; reticularis formation; tractus corticospinalis and corticonuclearis; nucleus nervi sensitive and motorius trigemini; nucleus nervi facialis; nucleus nervi hypoglossi, nucleus nervi vagi, nucleus rubralis, nucleus nervi oculomotorius and nucleus nervi throchlearis.*

KEY-WORDS: Central nervous system; brain stem; Cebus apella *comparative anatomy.*

It important to know the normal characteristics of the central nervous system of experimental animals, in order to investigate some cortical functions. Few authors describe the *Cebus apella* brain stem but more details are need in order to correlate these external aspects with the cyto-architecture.

Individual parts of brains have been observed by several authors (SMITH, 1903; INGALLS, 1914; CLARK, 1926; GEIST, 1930; HINES, 1933; PEELE, 1942; CONNOLLY, 1950; HEWITT, 1959; MYERS, 1962 and SCHNEIDER, 1968), but no large series was reported until then.

Since there are no studies about the brain stem of the *Cebus apella*, the aim of this report is to make an anatomical analysis of this part of the encephalon and to compare it to the brain stem of the *Callithrix jacchus* and to the man's one.

MATERIAL AND METHOD

In this study, the adults *Cebus apella* monkeys captured in the northern São Paulo, Brasil, were used.

The animals were anesthetized with an over inhalation of sulphuric ether. In this condition it was possible to dissect the carotid artery in the lateral surface of the neck. It was immediately injected 60 ml of 10 per cent formalin and during the perfusion the animals died.

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The animals were decapitated and their heads were preserved in 10 per cent formalin for better fixation. Afterwards, the brain was removed. In order to facilitate the examination of the superficial details, the piamater was stripped from the brain stem.

In the three brain stems parallel and successively cuts 2-3 mm thick were made according to the horizontal and sagittal sections, but three entire brain stems were kept intact for a gross anatomical study.

The blocks of four pieces were embedded in celloidin and horizontal sections 40 μ thick were obtained for histological analysis. Each one from five sections were stained by Pal-Weigert's technique modified by ERHART (1951) and Grenacher's Carmin. In the sections stained by this technique the medullated fibre bundles stand out in deep blue against a colourless red background.

RESULTS

The medulla oblongata of the *Cebus apella* is well developed and separated from the pons by the sulcus bulbo-pontinus and inferiorly from the spinal cord by decussatio pyramidum (Fig. 1). The pyramis are symmetric and separated from each other by the anterior median fissure. The root filaments of the nervus hypoglossus emerge from the anterolateral sulcus. The olive is characteristic. From the posterolateral sulcus, the root filaments of the nervus glossopharyngeus, vagus and accessorius emerge (Fig. 1).

On the dorsal surface (Fig. 2) of the medula oblongata ventriculus quartus and fasciculi gracilis and cuneatus with their corresponding tubercles are observed. They are separated from each other by the dorsal intermediate sulcus. The tuberculum trigemini and the pedunculus cerebellaris caudalis are also identified.

The pons of the *Cebus* is well developed. In the caudal borders of the pons, the nervi abducens, facialis intermedius and vestibulo cochlearis show their origin. The dorsal part of the pons forms the rostral portion of the floor of the ventriculus quartus (Fig. 2).

An elongated diamond-shaped cavity forms the ventriculus quartus (Fig. 2). The median and limiting sulci, vestibular areas and lateral recesses and the triangles of nuclei of the vagus and of the hypoglossus are observed. Also, in the roof of the ventriculus quartus the vela medullaria cranialis and caudalis and the tela choroidea may be observed.

In the ventral surface, the diverging pedunculus cerebri is present and it delimits the fossa interpeduncularis. The nervus oculomotorius emerges from the medial face of each peduncle (Fig. 1).

The colliculus caudalis and cranialis are observed in the tectum of mesencephalon (Fig. 2). They connect through their brachis to the corpora geniculata mediale and laterale, respectively. The nervus trochlearis emerges immediately below the colliculus caudalis.

The cerebellum of *Cebus apella* presents the cerebellar vermis and two cerebellar hemispheres well developed (Fig. 1). The posterolateral sulcis is marked; it separates the corpus cerebelli from the flocculonodular lobe which is well developed in this monkey.

The sagittal median sections of the cerebellar vermis (Fig. 3) shows a clear fissure prima between the cranial and caudal lobes. The cranial lobe is formed by the lingula, the central lobe and the culmen of the cerebellum which corresponds to the following parts of the hemisphere: alae of the central lobule and anterior quadrangular lobule. The posterior quadrangular lobule is formed by the declive, folium, tuber, pyramid and uvula in the cerebellar vermis which corresponds to the following parts of the hemisphere: lobulus simplex, superior and inferior semilunar lobules, biventral lobule and tonsil.

The cerebellar pedunculus cranialis, medium and caudalis are well developed in the *Cebus*.

The transition of the medulla spinal and medulla oblongata is characterized by the caudal portion of the decussatio pyramidum as noted in Fig. 4. At this level the gray matter, the ventral column with motor cellular grouping types, are well defined; the dorsal column is small and evidences the substantia gelatinosa. In the white matter the funiculus ventralis, the dorsalis and the right and left lateralis may be seen.

This section includes medially the fasciculus gracilis and lateraly the fasciculus cuneatus; the fasciculus lateralis and ventralis show the great quantity of myelinated fibres not identified to their function because the medulla is considered normal. The canalis centralis with the ependima is presented in eliptical form and it is surrounded by the substantia gelatinosa centralis. The formation reticularis is now apparent.

Fig. 5 shows a horizontal section through the medulla at the level of the decussatio pyramidum. The form of this segment is slightly circular and presents evident fissura mediana ventralis. The gray matter is greatly modified. The ventral portion is almost occupied by the decussatio of the tractus corticospinalis. In the gray matter it may also be noted the cellular grouping of the nucleus supraspinal nervi accessorii.

Dorsolaterally of the gray matter the nucleus tractus spinalis nervi trigemini may also be evidented.

The formation reticularis is more concentrated. The fasciculus of myelinated fibres are evident and the fasciculus gracilis and cuneatus are becoming identified.

The cranial part of the decussatio pyramidum shows the nucleus tractus spinalis nervi trigemini and the caudal portion of the nucleus dorsalis vagi and caudal portion of the nucleus olivaris (Fig. 6). Laterally the nucleus olivaris some fibres of the nervi hypoglossi can be seen. The formation reticularis is newly abundant.

The canalis centralis is displaced to the dorsal part and their ependymal cells are more evident. The white matter of the ventral part of the right and left medulla in this level shows the myelinated fibres corresponding to the corticospinalis tractus.

Fig. 7 demonstrates a horizontal section through the medulla at the level of the caudal part of the inferior olive. In the dorsal part of the section, it shows the fasciculus gracilis and cuneatus. The lemniscus medialis and fasciculus longitudinalis medialis are formed in the ventral portion of the gray matter of the canalis centralis. The nucleus olivaris is single but small convolutions can be noted. Dorsolaterally the nucleus tractus spinalis nervi trigemini is newly present. In the ventral surface the myelinated fibres are noted and they constitute the pyramid.

Fig. 8 shows a horizontal section through the medulla at level of the cranial part of the nucleus olivaris. The section includes the nucleus nervi hypoglossi, nucleus dorsalis vagi, nucleus tractus solitarius and nucleus ambiguus. Dorsally, the nucleus cuneatus and nucleus gracilis and small fasciculus of myelinated fibres are verified. On the central part the fasciculus longitudinalis medialis and lemniscus medialis may also be seen.

Fig. 9 indicates a horizontal section through the pons at the level of the nucleus nervi facialis. In the lateral part of the fourth ventriculus the cellular grouping of the nucleus vestibularis medialis, caudalis and lateralis are noted. The fasciculus longitudinalis medialis and the lemniscus medialis is apparent. The pons nucleus is distributed into the gray matter of its ventral part and the longitudinalis and transversalis tractus run laterally and reach the pedunculus cerebellar medius.

In the Fig. 10 it may be seen a horizontal section through the pons at the level of the genu nervi facialis. Laterally the nucleus vestibularis cranialis and near the sagittal median plan, the nucleus nervi abducentis surrounded by the fibres of the nervi facialis is well defined. The nucleus tractus spinalis nervi trigemini appears less evident, but the reticularis formation presents the same anterior aspect. The lemniscus medialis and the corpus trapezoideum are well delimited. The fasciculus longitudinalis medialis is also evident.

In the ventral part, the pons nucleus and the transversalis and longitudinalis tractus are well identified. In the section it may also be seen the part of cerebellum with the nucleus dentatus and emboliform.

Fig. 11 shows a horizontal section of the brain stem in the central region of the pons, passing through the area of the nucleus motorius nervi trigemini and the nucleus sensibilis nervi trigemini. In the dorsal part it is noted that the fourth ventriculus is more diminished and it is delimited superolaterally by the pedunculus cerebellaris cranialis.

In the ventral part of the pons, at this level, the fibres longitudinalis and transversalis are also abundant, in nucleus. The lemniscus medialis and lateralis, the corpus trapezoideum and fasciculus longitudinalis medialis are identified. In this section the cerebellum and its four nucleus: dentatus, emboliformis, globosus and fastigii may be seen.

Fig. 12 shows a horizontal section through the transition pons-mesencephalon. Medially to the fibres of the pedunculus cerebellaris cranialis, the nucleus tractus mesencephalic nervi trigemini are apparent. The leminiscus medialis is newly evident in the ventrolateral surface of the dorsal portion of the pons. In this section the lemniscus lateralis, fasciculus longitudinalis medialis and thick myelinated fibres that constitute the pedunculus cerebralis are also included.

Fig. 13 shows a horizontal section through the brain stem at the level of decussatio brachii conjuntivi. So, the plane of the section, makes evident the cellular grouping of the nucleus ruber fasciculus longitudinalis medialis, and lemniscus medialis and lateralis.

The substantia nigra is very extense in the *Cebus*. The fossa interpeduncularis is relatively deep at this level.

Fig. 14 shows a horizontal section through the brain stem at the level of the colliculus caudalis of the mesencephalon. This section passes through the aqueductus mesencephalicus transversally. The cellular grouping of the colliculus caudalis and the fibres of lemniscus lateralis entering it are also seen. The cranial fibres of the decussatio brachii conjunctivi that reach the nucleus ruber are also noted. The right and left pedunculus cerebralis, the fossula interpeduncularis and the radix nervi oculomotorii have appeared.

Fig. 15 shows a horizontal section through the mesencephalon at the level of the emergence of the nervus throclearis. Ventrolaterally to the aqueductus mesencephalicus and dorsally to the fasciculus longitudinalis medialis the nucleus nervi trochlearis is seen.

Medially, the fibres of the nervus throclearis situated in the nucleus tractus mesencephalicus nervi trigemini. This section includes the nucleus ruber, the colliculus caudalis and substantia nigra, that are well defined.

Fig. 16 shows a horizontal section through the brain stem at the level of the colliculus caudalis. The fibres of brachii colliculus caudalis is now apparent. The section passes through the nucleus nervi oculomotorii. In this section, the lemniscus medialis and lateralis, and the fasciculus longitudinalis medialis may also be seen.

Fig. 17 shows a horizontal section through the brain stem at level of the colliculus cranialis. The section includes parts of the epithalamus in the dorsal part of the brain stem that evidence the corpus geniculatum laterale. Here, the capsula interna, the nucleus lenticularis, the third ventriculus and commissura rostralis are also evidenced.

DISCUSSION

In the *Cebus* monkey, the brain stem presents itself more developed than the one of the *Callithrix jacchus*; all their parts - medulla oblongata, pons and mesencephalon - are very well marked as those of man and of other primates.

The pyramids and the oliva are well evidenced and macroscopically equivalent to the ones of rhesus, described by GEIST (1930) and man.

Basically, the pons of the *Cebus apella* presents similar characteristics to the ones of man and rhesus. The apparent origins of the cranial nerves of the pons are equivalent macroscopically as observed in man.

The IV ventricule morphology shows to be closer to man's morphology than the *Callithrix jacchus*. The eminentia medialis, the vestibular area and the trigonum nervi vagi and hypoglossus show the same aspects in the man and in the rhesus, but these aspects are not the same in the *Callithrix*. In the *Cebus apella* the colliculus facialis is not observed macroscopically.

The mesencephalon of the *Cebus apella* and the colliculi are prominent and the cerebral peduncles resemble more the human ones.

According to our results, in the cerebellum of the *Cebus apella* the verme cerebellar and the hemisphere cerebellum are very well verified. It is much more developed than the one of the *Callithrix jacchus* according to what was related by TILNEY *et alii* (1928) and REIS (1975). Fissures and folia resemble the human cerebellum although much simpler.

Our data also agree with the results described by SMITH (1903) and LARSELL (1943), which related the cerebellum hemispheres expansion and the deep fissures with a cerebellum more complex and evoluted.

The main cellular groups and the fiber bundles of the medulla oblongata of the *Cebus apella* are distributed in equivalent manners in the man, the gorilla (NOBACK & GOSS, 1959), and the *Callithrix jacchus* (REIS, 1975).

TILNEY *et alii* (1928) believe that the more or less development of the gracilis and cuneatus nuclei in primates, seems to be correlated with the afferent conduction of sensitive fibres of the anterior legs.

According to the results, the olivar nucleus of *Cebus* is bigger and better delimited than the one of *Callithrix* which is reported by BRUNER & SPIEGEL (1918) and REIS (1975).

The nuclear formations in the pons, the longitudinal tractus, corticospinallis and corticonuclearis, and also transversal fibres and corpus trapezoideum show to be more developed in the *Cebus*. The same structures in the human are better and well marked.

In the mesencephalon it may be observed the great development of the rubral nucleus that presents a similar aspect to that of man. In the *Callithrix*, according to BRUNNER & SPIEGEL (1918) and REIS (1975) the rubral nucleus is reported as being a small structure.

The cranial and caudal colliculus, the substantia nigra, and the cerebral pedunculus of *Cebus* seem more to the ones of man than those of *Callithrix*.

The development of the cerebellar formations in the *Cebus* are conspicuous. Verme and cerebellar hemispheres are well identified in the *Cebus*, however, the same structures are not found in the *Callithrix* as reported by REIS (1975). HERRICK (1924) points out that in the primates it may be noted two groups of cerebellar nuclei and REIS (1975) stated that the four main groupings of cerebellar nuclei in the *Calithrix* may not be seen perfectly well.

Our findings show that in the *Cebus* these four nuclei - dentatus, emboliformis, globosus and fastigii - are very well marked and they are similar to those of man.

The cerebellar peduncles in the *Cebus* are equivalent to those of man. REIS (1975) refers to the fact that in the *Callithrix* these peduncles are smaller because of the little development of the cerebral and cerebellar cortex.

SUMMARY AND CONCLUSIONS

Macro and microscopical observations were made on the brain stem and cerebellum

of the *Cebus apella*. Ten adult monkeys both male and females were used.

After removing the pia-mater, in the three brain specimens parallel and successive sections 2-3 mm thick according to the horizontal plan were made. The obtained sections were compared with those similar sections of man and of the *Callithrix jacchus*. Also, three entire brains were studied by using gross anatomy methods.

Four brains stems were dehydrated and embedded in celloidin and sections 40 μ thick were obtained for histological purposes. Each one from five sections were stained by Pal-Weigert's technique modified by ERHART (1951) and Carmin. In the stained sections the myelinated fibre bundle appears in deep blue against a red blackground.

The sections were examined under light microscope and stereomicroscope and compared with the similar sections of the brain stem from man and *Callithrix jacchus*.

The brain stem of the *Cebus* is more evoluted than that of *Callithrix*; the pons is distinguished very large including the nervi trigemini and the pedunculus cerebellar medium. The medulla oblongata is well defined; it presents the pyramidum and the oliva better delimited than those of *Callithrix*. Also, the IV ventriculus is more evoluted than that of *Callithrix*. Although these structures are smaller in the *Cebus* than in the human they may be considered equivalent in both primates.

On the tectus mesencephalicus the colliculus cranialis and caudalis may be seen; the pedunculus cerebralis is very large as well as that seen in man.

The cell groupings of the medulla oblongata are well defined: nucleus gracilis, cuneatus, accessory cuneatus, olivaris and accessory olivaris dorsalis and medialis.

The pedunculus cerebellaris caudalis and their myelinated fibre bundles are more developed than those of *Callithrix* and less developed than those of man.

On the pons, the cell groupings and reticularis formation are much larger than those of the *Callithrix jacchus*. However, these formations are less developed than those of man. The tractus corticospinalis, corticonuclearis, and the pedunculus cerebellaris medialis can be noted and more easily identified in the *Cebus*, than in the *Callithrix*. In man the same aspects are more developed.

In the mesencephalon, the colliculus cranialis and caudalis are more developed than those of the *Callithrix*. The substantia nigra is extense, more delineated; the pedunculus cerebellaris cranialis and pedunculus cerebralis are very large as may be seen in man.

The cerebellar structures are observed to be more evoluted than those of the *Callithrix*. The folias and fissures are already perfectly defined. This aspect is not seen in the *Callithrix jacchus*.

About the internal aspects, we find that the folias and the white matter with the nucleus cerebellaris are well differentiated. In the *Cebus*, the nucleus dentatus, emboliformis, globosus and fastigii are developed and have no similar in the *Callithrix*. The same nuclei in man are more evoluted and better delimited.

ACKNOWLEDGEMENTS

The author would like to express his thanks to Prof. Dr. Eros Abrantes Erhart, Chief of the branch of Neuranatomy of de Department of Anatomy, School of Medicine, University of São Paulo for the orientation in the elaboration of this paper.

Thanks are due to Mrs. Catarina Mafra for her assistance in preparing the materials for this study and also to Mr. Renato Ferreira da Silva for helping with the photographic work.

WATANABE, I. — Comparative study of the medulla oblongata, pons, mesencephalon and cerebellum of the tufted capuchin, **Cebus apella** Linnaeus, 1758. **Rev. Odont. UNESP**, São Paulo, **11**(1/2):13-25, 1982.

WATANABE, I. Estudo comparativo da medula oblonga, ponte, mesencéfalo e cerebelo do macaco **Cebus apella Linnaeus**, 1758. **Rev. Odont. UNESP**, São Paulo, **11**(1/2):13-25, 1982.

RESUMO: Observações macro e microscópicas do tronco encefálico e cerebelo do Cebus apella *foram realizadas em 10 encéfalos de macacos adultos, de ambos os sexos. Após a remoção total da pia-mater procedeu-se ao estudo da morfologia em geral em seis peças. Em três delas praticamos cortes paralelos e sucessivos com cerca de 2-3mm de espessura orientados segundo o plano transversal. As fatias assim obtidas foram confrontadas com as obtidas no homem e no sagüi* Callithrix jacchus *em planos similares. Três outras peças, conservadas intactas, serviram para o estudo macroscópico da morfologia externa. As quatro peças restantes, após a remoção das meninges, foram submetidas a desidratação e inclusão em Celoidina. Foram efetuados cortes seriados de 40μ de espessura. Um em cada cinco cortes foi corado pela técnica de Pal-Weigert modificada por ERHART (1951) para as bainhas de mielina e com coloração de fundo pelo Carmin.*

Esses cortes foram estudados em um microscópio e estereomicroscópio Zeiss e comparados com cortes seriados equivalentes de segmentos humanos e do Callithrix jacchus. *O tronco encefálico é mais desenvolvido que o do sagüi; destaca-se a ponte bem nítida incluindo o nervo trigêmeo e o pedúnculo cerebelar médio. A medula oblonga, perfeitamente delimitada, apresenta as pirâmides e a oliva maiores e melhor esboçadas em relação as dos sagüi. Na face dorsal, o IV ventrículo também é maior e mais nítido do que no sagüi. Essas formações são equivalentes às da espécie humana, embora sejam relativamente menores que as do homem. Ainda, no mesencéfalo destacam-se os colículos craniais e caudais, grandemente desenvolvidos e melhor delimitados do que no sagüi; os pedúnculos cerebrais mais volumosos que os do saguí, são semelhantes e equivalentes aos do homem. Na medula oblonga há um grande desenvolvimento dos grupamentos celulares; núcleos grácil, cuneiforme, cuneiforme acessório, olivar e olivares acessórios dorsal e medial. O pedúnculo cerebelar caudal e os feixes de fibras nervosas são mais desenvolvidos do que os do sagüí e menos do que os do homem. Os grupamentos celulares da ponte no* Cebus *são muito mais desenvolvidos do que aqueles observados no sagüi; todavia são menos desenvolvidos do que na espécie humana. Os feixes de fibras corticospinais, corticonucleares e o pedúnculo cerebelar médio são mais desenvolvidos do que os do sagüi e menos desenvolvidos quando comparados aos do homem. No mesencéfalo, os colículos craniais e caudais são maiores e mais desenvolvidos do que os do sagüi. A substância negra é extensa, muito mais nítida do que no sagüi. Os pedúnculos cerebrais e cerebelares craniais são bastante evoluídos comparativamente aos do sagüí, as estruturas acima referidas muito se assemelham às do homem. O cerebelo no* Cebus *é bastante evoluído, já apresenta folhas e fissuras perfeitamente definidas e que no sagüí suas diferenciações não são tão nítidas. Essas estruturas são particularmente semelhantes àquelas encontradas na espécie humana. As folhas e os núcleos cerebelares — denteado, emboliforme, globoso e fastigial — no* Cebus *são mais desenvolvidas do que no sagüi, no qual não são evidentes os quatro núcleos. Essas estruturas assemelham-se muito às correspondentes do homem.*

REFERENCES

BRUNNER, H. & SPIEGEL E.A. 1918. Vergleichende anatomisch Studien an Hapaliden gehirn. *Folia neuro-biol., 11:*171-203.

CLARK, W.E. Le Gross. 1926. Description of the cerebral hemispheres of a gorilla. *J. Anat., 61:*467-475.

CONNOLLY, C.J. 1950. *External Morphology of the Primate Brain*. Springfield, C.C. Thomas.

ERHART, E.A. 1951. Modificações simples e rápidas do método de Pal-Weigert para a coloração das bainhas de mielina. *Arq. Neuro-Psquiat., 9:*372-374.

GEIST, F.D. 1930. The brain of the Rhesus monkey. *J. comp. Neurol., 50:*333-376.

HERRICK, C.J. 1924. Origin and evolution of the cerebellum. *Arch. Neurol. Psychiat., 11:*621-652.

HEWITT, W. 1959. The mammalian caudate nucleus. *J. Anat., 93:*169-177.

HINES, M. 1933. The external morphology of the brain and the spinal cord. *In:* HARTMAN, C.G. & STRAUS, W.L. *The Anatomy of the Rhesus monkey*. New York, Hafner Publishing Co.

INGALLS, N.W. 1914. The parietal region in the primate brain. *J.comp. Neurol., 24:*291-341.

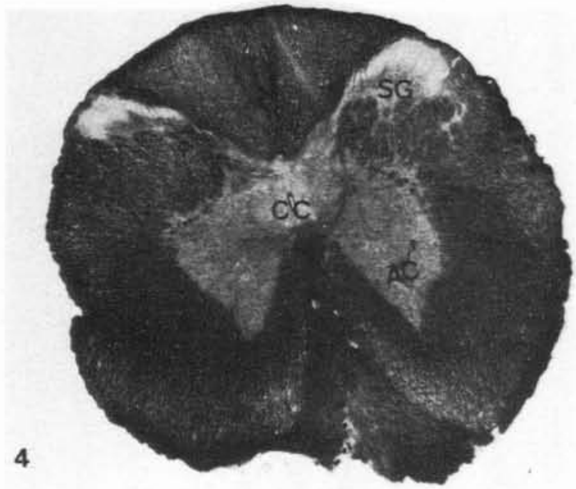
LARSELL, O. 1934. Morphogenesis and evolution of the cerebellum. *Arch. Neurol. Psychiat., 31:*373-395.

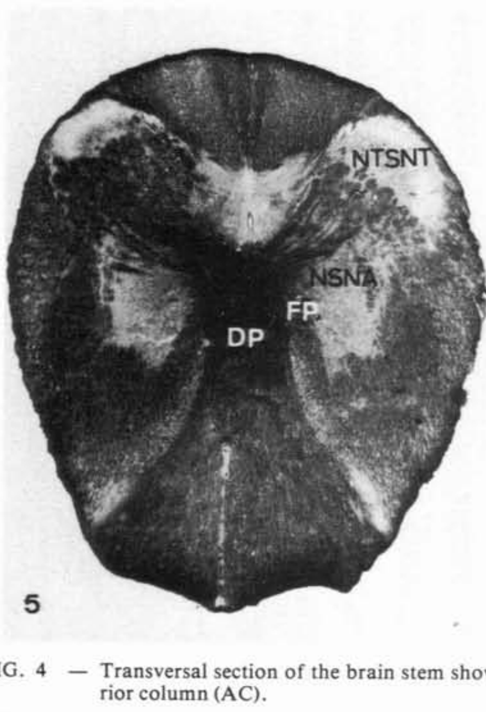
MYERS, R.F. 1962. Commissural connections between occipital lobes of the monkey. *J. comp. Neurol., 118:* 1-10.

NOBACK, C.R. & GOSS, L. 1959. Brain of a gorilla. I. Surface anatomy and cranial nerve nuclei. *J. comp. Neurol., 111:* 321-343.

PEELE, T.L. 1942. Cyrtoarchitecture of individual parietal areas in the monkey and the distribution of the different fibres. *J. comp. Neurol., 77:*693-737.

REIS, F.P. 1975. *Considerações macro e microscópicas sobre encéfalo do sagüi.* Tese de Mestrado. Escola Paulista de Medicina, São Paulo.





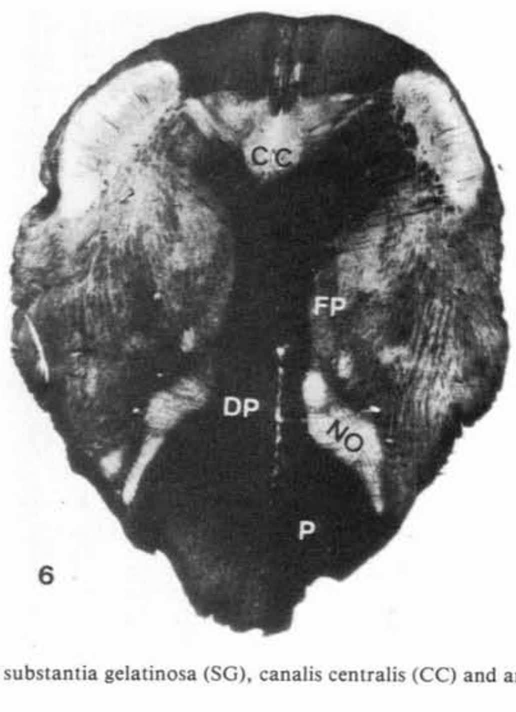
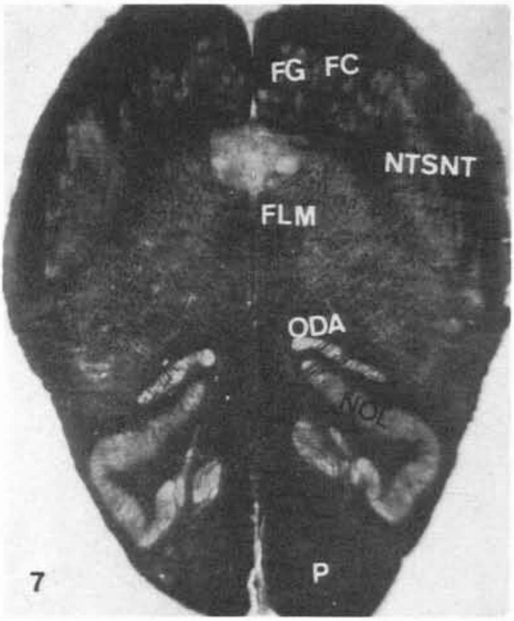
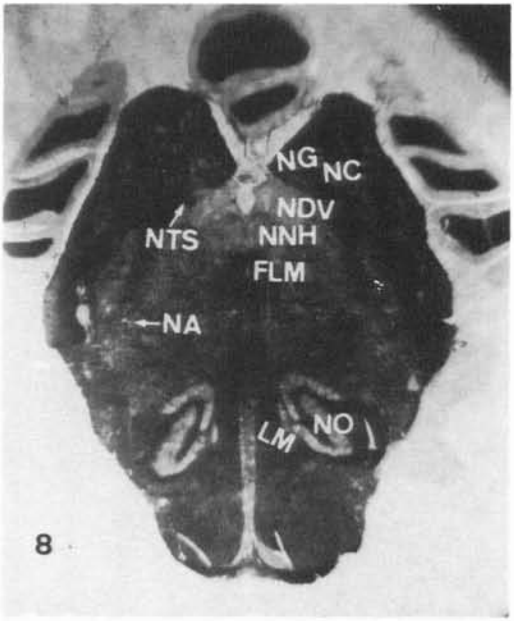


FIG. 4 — Transversal section of the brain stem showing substantia gelatinosa (SG), canalis centralis (CC) and anterior column (AC).

FIG. 5 — Transversal section of the medulla oblongata showing the nucleus tractus spinalis nervi trigemini (NTSNT), nucleus supraspinal nervi accessorii (NSNA), fasciculus propius (FP), and decussatio pyramidum (DP).

FIG. 6 — Transversal section of the medulla oblongata showing the canalis centralis (CC), fasciculis propius (FP), decussatio pyramidum (DP), nucleus olivaris (NO) and pyramis (P).





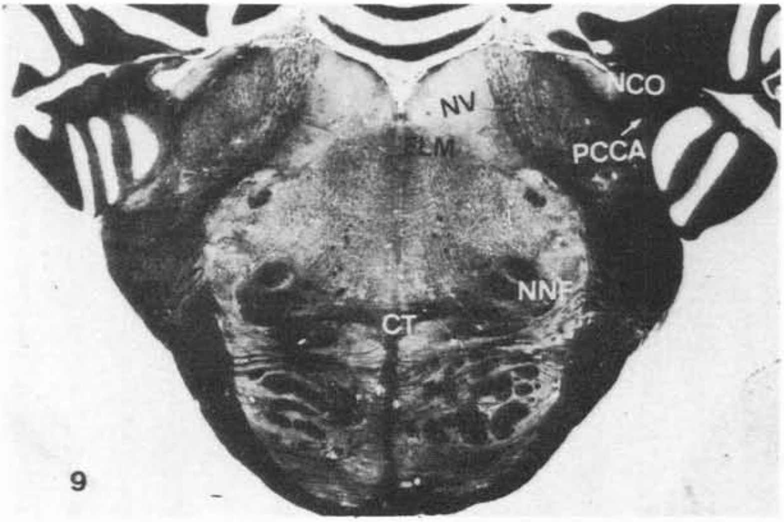
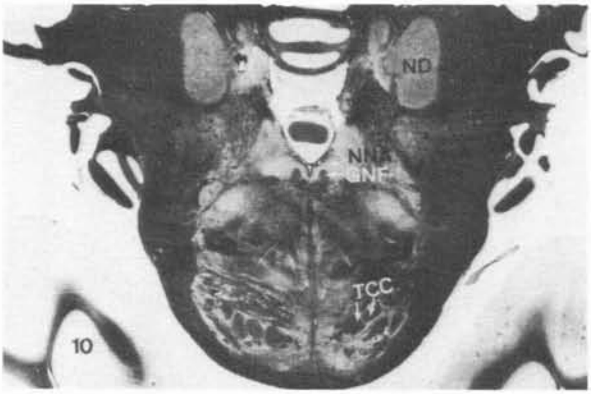
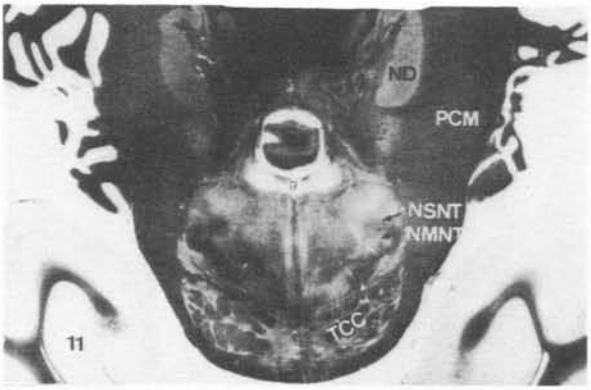


FIG. 7 — Transversal section of the medulla oblongata showing the fasciculus gracilis (FG), fasciculus cuneatus (FC), nucleus tractus spinalis nervi trigemini (NTSNT), fasciculus longitudinalis medialis (FLM), oliva dorsalis accessorius (ODA) and nucleus olivaris (NO).

FIG. 8 — Transversal section of the medulla oblongata showing the nucleus gracilis (NG), nucleus cuneatus (NC), nucleus dorsalis vagi (NDV), nucleus tractus solitarius (NTS), nucleus nervi hypoglossi (NNH), fasciculus longitudinalis medialis (FLM), nucleus ambigus (NA), nucleus olivaris (NO) and lemniscus medialis (LM).

FIG. 9 — Transversal section of the pons showing the nucleus vestibularis (NV), fasciculus longitudinalis medialis (FLM), nucleus cochlearis (NCO), pedunculus cerebellaris caudalis (PCCA), nucleus nervi facialis (NNF) and corpus trapezoideum (CT).





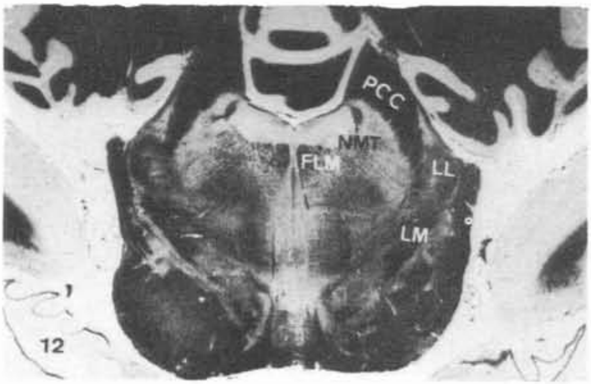
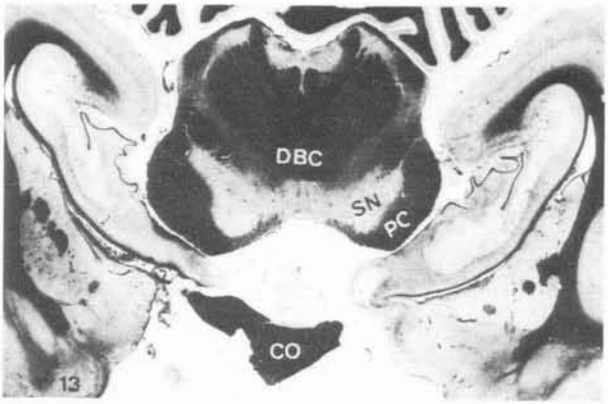
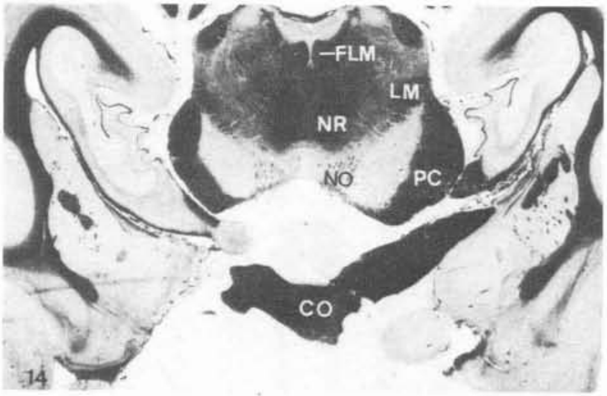


FIG. 10 — Transversal section of the pons showing the nucleus dentatus (ND), nucleus nervi abducentis (NNA), genu nervi facialis (GNF), tractus corticospinalis and corticonuclearis (TCC).

FIG. 11 — Transversal section of the pons showing the pedunculus cerebellaris medius (PCM), nucleus dentatus (ND), nucleus sensorius nervi trigemini (NSNT), nucleus motorius nervi trigemini (NMNT), and tractus corticospinalis and corticonuclearis (TCC).

FIG. 12 — Transversal section of the mesencephalon showing the pedunculus cerebellaris cranialis (PCC), fasciculus longitudinalis medialis (FLM), lemniscus medialis (LM), lemniscus lateralis (LL), and nucleus mesencephalicus trigemini (NMT).





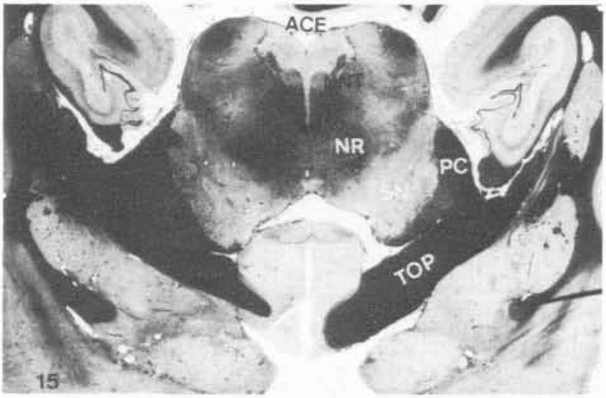
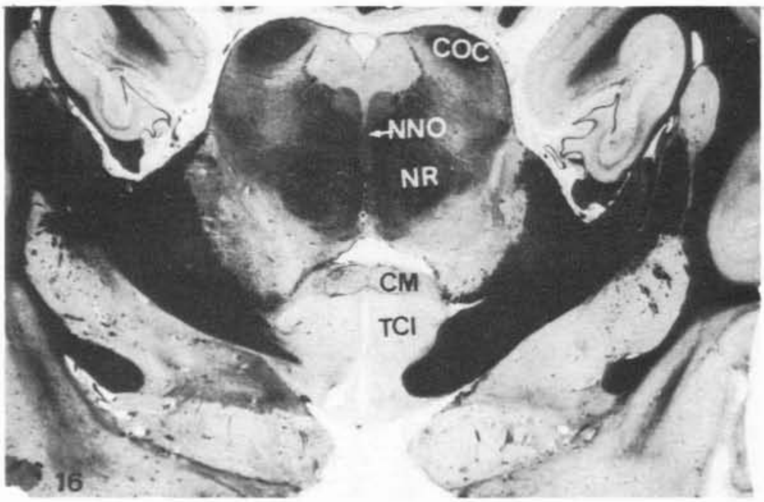


FIG. 13 — Transversal section of the mesencephalon showing the decussatio brachii conjuctivi (DBC), substantia nigra (SN), pedunculus cerebralis (PC), chiasma opticum (CO).

FIG. 14 — Transversal section of the mesencephalon showing the fasciculus longitudinalis medialis (FLM), lemniscus medialis (LM), nucleus ruber (NR), nervi oculomotorius (NO), pedunculus cerebralis (PC) and chiasma opticum (CO).

FIG. 15 — Transversal section of the mesencephalon showing the aqueductus cerebri (ACE), nucleus nervi trochlearis (NNT), nucleus ruber (NR), substantia nigra (SN), pedunculus cerebralis (PC) and tractus opticus (TOP).



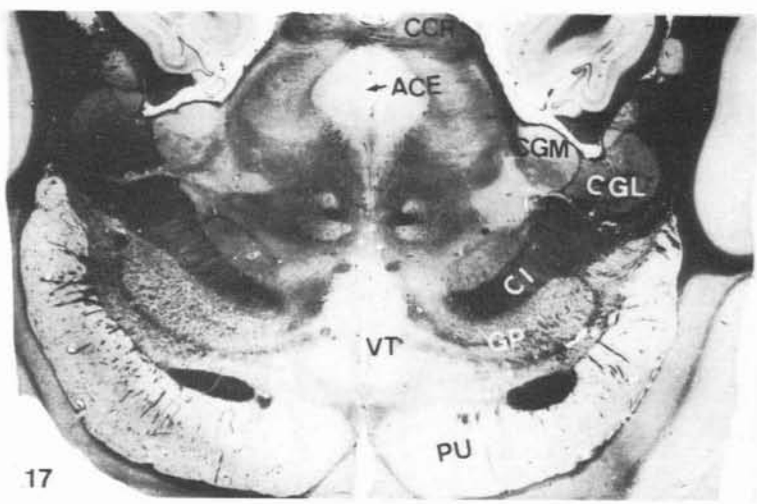


FIG. 16 — Transversal section of the mesencephalon showing the colliculus caudalis (COC), nucleus nervi oculomotorius (NNO), nucleus ruber (NR), corpus mammilaris (CM), and tuberculum cinereum (TCI).

FIG. 17 — Transversal section of the mesencephalon showing the colliculus cranialis (CCR), aqueductus cerebri (ACE), corpus geniculatum mediale (CGM), corpus geniculatum laterale (CGL), capsule interna (CI), globus pallidus (GP), ventriculus tertius (VT) and putamen (PU).