Journal of Morphological Sciences
J Morphol Sci
Brazilian Society of Anatomy

Original Article
J Morphol Sci 2023;40:407-412

Conceptual and Topographical Contrapositions in Neuroanatomy

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Disclose and conflicts of interest: none to be declared by all authors

ABSTRACT

Introduction: concepts and Topography are foundations for the study of Anatomy; that is, the former aims at outlining the ideational essence of vocabulary representation; the latter, referring to the location of different previous components. Although these two pillars aim to standardize atlases and anatomical books, some theoretical and topographic disagreements are still evident, mainly in Neuroanatomy. The aim of this study is to assess conceptual and topographic contrasts in Neuroanatomy.

Materials and Methods: variables were subdivided into two groups: conceptual analysis on the nuclei of the base of the telencephalon, paleocerebellum, medial occipitotemporal gyrus, thalamus and axonal corpuscles; and topographic examination of the spinal and medial lemnisci, medullary striae of the fourth ventricle, and cranial nerve VI (abducens), VII (facial), and VII (vestibulocochlear). In the last two decades, 39 titles with their text as well as their imaging contents were considered, as well as two etymological criteria (in Greek or Latin), 13 journals in Health Sciences and the most recent World Anatomical Terminology translated into Portuguese.

Results: no absolute, conceptual or topographic consensus regarding the variables evaluated was found.

Conclusion: conceptual and topographical contrasts could be a consequence that many authors over the past two centuries have tended to faithfully copy their predecessors rather than contradict or expose alternatives to long-generated dogmas. Effects of these inadequacies include inaccuracies in learning and risk of iatrogenics in Health Sciences.

Keywords: Neuroanatomy; Nervous System; Concept; Topography; Contraposition.

Introduction

The term concept is understood as the perception of something or someone[1]; in Anatomy; it consists of naming and understanding structures of the Human Body. The compilation of organic definitions comprises Anatomical Terminology, which aims to capture the ideational essence of what each word represents, in order to characterize and apply it[2]. Several anatomical terms refer to positional relationships and, therefore, from Topography; a branch of Anatomy that allows elucidating and specifying the location of different structural components to relate them spatially[3].

Although Anatomical Terminology and Topography aim to standardize atlases and books on Anatomy[3], some perceptions and locations pointed out in these compendia may have slight differences when presented by different authors. In Neuroanatomy, there is evidence that certain records on position as well as conceptualizations are not under ideal consensus in Health Sciences and in Neuroanatomy[4-7].

Historically, conceptual oppositions in Anatomy have unfolded over the centuries, depending on the prevailing way of thinking at each time. During the pre-Socratic period, the awakening of scientific thought, it was believed that everything was created by a fundamental substance. In addition, from this presupposition, it was tried to adjust certain justifications based on observations, mainly in neuroanatomical studies[8].

During Classical Antiquity, the Neurosciences received significant contributions (although not very precise) with the description of cranial nerves. Between the 17th and 18th centuries, neurophysiological advances could be observed, especially from the differentiation of the telencephalic cortex and the concept of blood supply[8,9]. Anatomical Terminology has been gradually restructured throughout history. In 1895, a first attempt at standardization was carried out and became known as "Basle Nomina Anatomica". The last review was in 1998; it was called "International Anatomical Terminology", with the aim of standardizing the 7,683 terms in English. In general, Portuguese terminology and Greek-Latin stems have been translated based on this convention[10].

Although, Neuroanatomical History is secular, there are still theoretical[11-13] and topographical[13] disagreements, standing out the atlases. In up to 93% of cases, the sixth cranial pair is caudal to the seventh and eighth adjacent pairs, which is not described in the related literature and raises the risk of severe iatrogenesis[14]. Knowledge about Topography and anatomical conceptual details is crucial for neuroimaging analysis as well as the accurate diagnosis in Medicine[15-17]. With the accelerated technological

DOI: 10.51929/jms.40.407.2023
ISSN 2177-0298

advance in the last decades, there has been a risk of underestimating the basic theoretical understanding, which includes the conceptual and topographical interpretation of components of the Human Body[18]. These stems from the fact that many authors, in the last two centuries, have tended to faithfully copy their predecessors rather than contradicting or exposing alternatives to long-established dogmas[14].

In Health Sciences, updating and carrying out concepts are of paramount importance in the current setting for Surgery, Imaging, Internal Medicine, Pediatrics, Gynecology and Obstetrics[19]. Taking into account the significance of standardizing certain definitions and topographical relationships for the learning of the Nervous System; the objective of this study is to identify topographical and conceptual contrapositions in Neuroanatomy.

Materials and Methods

The collection of the Anatomical Library of the School of Medicine São José do Rio Preto, FAMERP, SP[20] was considered for researching a total of 339 titles in Health Sciences, including compendia and atlases. Anatomical topics in journals and etymological dictionaries were also selected. As this is considered a scientific literary analysis, there was no need for prior submission of this study to the Ethics Committee for Research on Human Beings, according to the Resolution Nº. 510/2016 of the National Health Council[21].

Variables considered were subdivided into two groups for conceptual or topographic assessment of anatomical structures. In the first group, the conceptual analysis was compiled on the nuclei of the base of the telencephalon, paleocerebellum, axonal corpuscles, medial occipitotemporal gyrus and thalamus[22]. In the second group, it was considered to examine the topographic description of the following structures: spinal and medial lemniscus, medullary striae of the fourth ventricle and pairs of cranial nerves VI (abducens), VII (facial) and VIII (vestibulocochlear)[23]. Results on conceptual or topographic investigations were compiled in tables, with application of descriptive statistics[24] by frequency of occurrence or arithmetic mean and standard deviation (for the year of publication of the anatomical studies). Words that do not appear in the current Nomina Anatomica[60], when cited by different authors, were kept in quotation marks.

Results

A total of 39 titles with their text as well as their and imaging contents were considered for analysis (19 on Anatomy, eight on Neuroanatomy, five on Physiology, three on Neurology, two on Neurosciences, one on Pathology and one on Neurosurgery), with arithmetic and standard deviation per year of publication equal to 2004.35±8.38 years. Thirteen journals in Health Sciences were also considered for analysis, with arithmetic mean and standard deviation per year of publication equal to 2014.14±4.81 years. For standard referential support, two classical etymological dictionaries, one in Greek and one in Latin[58,59], as well as the most recent publication of the World Anatomical Terminology translated into Portuguese[60].

Table 01 shows conceptual divergences found on the composition of the nuclei of the base of the telencephalon.

Table 01. Conceptual contrasts regarding the nuclei constitution of the telencephalon basis in 23 investigated studies and their respective frequency of occurrence.

Neuroanatomic Structure	Conceptual Contrapositions	Frequency of Occurrence
Nucleio of the base of telencephalon	Globus Pallidus, Caudate Nucleus and Putamen[3,28,39,40,44]	21,74% (n=5)
	Globus pallidus, Caudate Nucleus, Subthalamicus Nucleus, Putamen and Substantia Nigra of the Midbrain[4,30,32,35,36]	21,74% (n=5)
	Claustrum, Amygdaloide Body, Globus pallidus, Caudate Nucleus and Putamen[27,33,38,42]	17,39% (n=4)
	Claustrum, Globus pallidus, Caudate Nucleus and Putamen[26,34]	8,70% (n=2)
	Claustrum, Amygdaloide Body, Globus pallidus, Caudate Nucleus, Subthalamicus Nucleus, Putamen and Thalamus[25]	4,35% (n=1)
	Claustrum, Amygdaloide Body, Globus pallidus, Accumbens Nucleus, Basilar Nucleus of Meynert, Caudate Nucleus and Putamen[29]	4,35% (n=1)
	Globus pallidus, Accumbens Nucleus, Caudate Nucleus, Subthalamicus Nucleus, Putamen e Substantia Nigra of the Midbrain[31]	4,35% (n=1)
	Amygdaloide Body, Globus pallidus, Caudate Nucleus and Putamen[37]	4,35% (n=1)
	Caudate Nucleus, Subthalamicus Nucleus, Putamen and Substantia Nigra[41]	4,35% (n=1)
	Anterior tegmental area, Globus pallidus, Caudate Nucleus, Accumbens Nucleus, Subthalamicus Nucleus, Putamen and Substantia Nigra[43]	4,35% (n=1)
	Claustrum, Amygdaloide Body, Caudate Nucleus and Putamen[45]	4,35% (n=1)

Table 02 shows dissonances regarding the paleocerebellum, definition of axonal and thalamus, and the existence or not of the medial occipitotemporal gyrus.

Table 03 reveals the presence of positional inconsistencies (identified in atlases or in textbook images) in relation to spinal and medial lemnisci, medullary striae of fourth ventricle and the sixth (VI), seventh (VII) and eighth (VIII)) pairs of cranial nerves.

Discussion

The objective of this study was to compile and discuss about certain neuroanatomical descriptions, definitions and topographical relationships. Understanding of the components of the nuclei of the base has generated different interpretations in disagreement (Table 01). The term "nuclei" comes from the Latin nucleus and means center, middle[58]. The Greek term "basilon", on the other hand, has by

Table 02. Conceptual disagreements regarding the paleocerebellum composition (in 13 evaluated works); concept of axonal corpuscles (in 13 works) and thalamus (in 18 works); and citation or not of the existence of the medial occipitotemporal gyrus (in 18 works), with respective frequencies of occurrence.

Neuroanatomic Structure	Conceptual Contrapositions	Frequency of Occurrence
Paleocerebellum	Anterior Lobe, Pyramid and Úvula[3,29,31,42]	30,77% (n=4)
	Vermis and Adjacentes zones of the vermis[36,40]	15,38% (n=2)
	Anterior Lobe[30,41]	15,38% (n=2)
	"Paraflocculus", Pyramid, "Vermis Portion of the Anterior Lobe" and Úvula[34,46]	15,38% (n=2)
	Anterior Lobe (vermis portion) and Medial Part of Posterior Lobe[28]	7,69% (n=1)
	Vermis, only[38]	7,69% (n=1)
	Intermediate Hemisphere, Fastigial Nucleus, "Interpositus Nucleus" and Vermis[43]	7,69% (n=1)
	Culmen, "Central Lobe and your Wing", Quadrangular Lobule, Pyramid and Úvula[44]	7,69% (n=1)
	Anterior Lobe, "Adjacent Paravermian Zones", Pyramid, Úvula, "Paraflocculus" and "Amygdaloide"[45]	7,69% (n=1)
Axonal Corpuscles	Modified Axon[28-30,33,38,40-43,51]	76,92% (n=10)
	Dendrite [31,32,39]	3,08% (n=3)
Thalamus	Made up of two ovoid masses[3,25,28-30,31,33,38,39,41-46]	83,33% (n=15)
	Made up of one ovoid masse[24,40,47]	16,67% (n=3)
Medial Occipitotemporal Gyrus	Existence cited[3,4,23,29,31 42,44,48,49,50]	55,56% (n=10)
	Existence did not cite[25,27,38,40,41,43,47]	38,89% (n=7)
	Cited the existence of "Occipitotemporals gyrus Internal and External"[45]	5,56% (n=1)

Table 03. Topographic contrasts concerning spinal and medial lemnisci (in 16 titles consulted), medullary striae of the fourth ventricle (in 11 titles) and the sixth (VI), seventh (VII) and eighth (VIII) pairs of cranial nerves (in 27 titles evaluated), with their respective frequencies of occurrence.

Neuroanatomic Structure	Conceptual Contrapositions	Frequency of Occurrence
Spinal and Medial Lemnisci	Medulla oblongata, Pons and Mesencephalon[27,29,32,33,38,40,42,43,45,49,50]	68,75% (n=11)
	Pons and Mesencephalon[28,35,36,39,44]	31,25% (n=5)
Medullary Striae of fourth ventricule	Three medullary striae available obliquely[4,28,29,31,44,45,49]	63,64% (n=7)
	Three medullary striae available horizontally[23,40,52]	27,27% (n=3)
	One medullary striae available obliquely[41]	9,09% (n=1)
VI, VII and VIII Cranial Nerves	In order from cranial to caudal, there are VI, VII and VIII[3,4,22,23,27,29-31,35,38-42,45-47,49,52-54,56,57]	82,14% (n=23)
	VI and VII are located practically on the same horizontal line, with VI more medial and VII more caudal; nerve VIII is caudal to both [28,33,55]	10,71% (n=3)
	VI, VII e VIII are located practically on the same horizontal line[43]	3,57% (n=1)
	In the cranial to caudal order, there are VIII, VII and VI[14]	3,57% (n=1)

definition "lower part"[59]. Thus, "nuclei of the basis" corresponds to "bottom center" in the case of the telencephalon. According to the current international anatomical nomenclature[60], the caudate nucleus, putamen and globus pallidus are part of the nuclei of the base of the telencephalon. In addition to these three structures, other components for the basal nuclei have been included, such as the claustrum, amygdaloid body, subthalamic nucleus, substantia nigra, nucleus accumbens, basal nucleus of Meynert or the anterior tegmental area (Table 01).

There are also conceptual discrepancies regarding the definition of paleocerebellum (Table 02). The term palaios is of Greek origin and symbolizes an ancient historical period[59], while cerebellum derives from the Latin and refers to "little brain"5[8]. International Anatomical Terminology conceptualizes the paleocerebellum as corresponding to the cerebellar vermis[60]. However, the present study shows that most of the consulted authors includes the anterior lobe, pyramid and uvula as components of the paleocerebellum (Table 02). On the other hand, paleocerebellum can also encompass posterior lobe, "paraflocculus", fastigial nucleus, "interposite nucleus" (globular nucleus), culmen, cerebellar lobes, "tonsils" (amygdaloid bodies), areas adjacent to the cerebellar vermis or central and quadrangular lobes. It is worth observing, however, that current world terminology discourages the use of additional inclusions, since such regions – even if they phylogenetically emerged at a similar time – have multiple connections[60].Although a considerable amount of references reinforces the concept of axonal corpuscles (Table 02), discrepancy arises on the subject. Axonal corpuscles correspond to a type of modified axon belonging to pseudounipolar neurons[42]. However, they may refer to the functional activity of dendrites[31,32,39], since each pseudounipolar neuron has only one afferent branch, which justifies such conceptual dissonance. As for the thalamus, in turn, there is wide acceptance of being constituted by two ovoid masses (Table 02). However, there is scientific confrontation to defend the definition that the thalamus is composed of a single ovoid mass[24,40,47].

Likewise, topographic contrasts are present in the neuroanatomical literature. The existence of the medial occipitotemporal gyrus is evident in most of the studies consulted (Table 02). However, among the 18 references consulted, seven of them have not mentioned the presence of such telencephalic structure. Also "internal and external occipitotemporal gyrus" was reported[18]. The exact placement of the Greek term lemniscus (leminiskós), meaning ribbon or strip[59], has not been found in the same context. In line with current International Anatomical Terminology[60], the medial and spinal lemnisci are part of the pons and midbrain. Nevertheless, in the literature examined, the greater number of references reinforces the need to also add the medulla oblongata as a primordial component (Table 03).

Similarly, the arrangement and number of medullary striae of the fourth ventricle do not show consensus in anatomical atlases. Most of the consulted compendia shows figures with three striations arranged obliquely, on each side of the rhomboid fossa. However, there are illustrations with three bilateral horizontal streaks, or even just one oblique medullary streak for each half of the fourth ventricle (Table 03). Similarly, it is commonly seen in atlases that pairs VI, VII and VIII of cranial nerves are arranged in this order, from medial to lateral and craniocaudal, in the bulbopontine sulcus. However, there are reports that pairs VI and VII are on the same horizontal line, cranially to pair VIII, or that they are located on the same horizontal line (Table 03). On the other hand, recent descriptions in vivo during neurosurgical procedures have shown that the three pairs are not located at the same level of emergence and that their order, from cranial to caudal (in the lateromedial direction), shows to be VIII, VII and VI[14]. The present study has stood out the inclusion of images from atlases, reports or descriptions of textbooks published in the last two centuries in an interval of sixteen years, as well as periodicals from the last decade, although there may be many other compendia consecrated throughout the Anatomical History. This study showed evidence of conceptual and topographical oppositions in these selected topics of Neuroanatomy, as well as the need for reformulations or updates to provide more accurate academic and professional learning, mainly for the various areas of Health studies[61].

Conclusion

In Neuroanatomy, there are divergences regarding the Concept of the nuclei of the base of the telencephalon, paleocerebellum, axonal corpuscles, thalamus and medial occipitotemporal gyrus. In Topography, there are discrepancies regarding spinal and medial lemniscus, medullary striae of the fourth ventricle and sixth, seventh and eighth pairs of cranial nerves. Conceptual and topographical contrasts can be a consequence of the fact that many authors, in the last two centuries, have tended to faithfully copy their predecessors rather than contradicting or exposing alternatives to long-established dogmas. Effects of these inadequacies result inaccuracies in learning and risk of iatrogenics in Health Sciences.

Acknowledgments

The authors sincerely thank the Anatomical Library of the School of Medicine São José do Rio Preto (FAMERP), SP.

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Received: January 1, 2023
Accepted: March 3, 2023

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