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Diaschisis: brief historical review

Abstract. Background. This article is devoted to the Monakow concept of diaschisis and its brief historical review. We analyze the origin and history of diaschisis. **Materials and methods.** We have overviewed scientific publications for the period of 1900–2018. The Scopus, Web of Science, MEDLINE, ScieLo, PubMed, The Cochrane Library, EMBASE, Global Health, CyberLeninka, and RINC databases were used along with databases of government scientific libraries of Ukraine, the European Union, the United Kingdom, and the USA. Among scientific books and articles that were found based on keywords, 35 research publications met the established eligibility criteria and were analyzed. **Results.** Constantin von Monakow was a Russian-origin Swiss neurologist and an outstanding scientist of his time. He will be remembered by his important contributions to our knowledge on the organization, location, and direction of tracts of the nervous system. The Monakow concept of diaschisis is placed at the center of the understanding of brain function. It draws scientific attention to the dynamics of the nervous system, remote lesion effects, and recovery of function. **Conclusions.** We have analyzed the origin of diaschisis, history of its discovery, and pathophysiological mechanisms.

Keywords: diaschisis; history; origin; pathophysiology; Monakow concept of diaschisis; Constantin von Monakow

Introduction

This article is devoted to the Monakow concept of diaschisis, and its brief historical review. We analyze the origin and history of diaschisis.

Materials and methods

We have overviewed scientific publications for the period of 1900–2018. The Scopus, Web of Science, MEDLINE, ScieLo, PubMed, The Cochrane Library, EMBASE, Global Health, CyberLeninka, and RINC databases were used along with databases of government scientific libraries of Ukraine, the European Union, the United Kingdom, and the USA. Among scientific books and articles that were found based on keywords, 35 research publications met the established eligibility criteria and were analyzed.

Results

The idea that damage to one part of the nervous system can have effects at a distance was popular in XIX century. Constantin von Monakow, MD, accepted this idea and

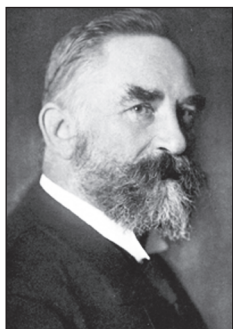
blended it with the newly formulated neuron doctrine early in the XX century to account for ipsilateral paralyzes and recovery of function [1]. In 1914, Monakow presented a new concept of neural depression due to loss of inputs to structures connected to the focal brain lesion, named it diaschisis [2–4].

Definition

Diaschisis (from Greek *diaschisis* — splitting, dividing) [1] is a state of inactivity of nerve centers or accumulation of cellular elements located at a distance from the primary lesion, but functionally connected with it by a system of conducting paths [5–10].

As a result of the sudden cessation of the influx of physiological stimulating impulses to the nervous structures of the functional system with effector functions, the responsive reactions are damaged and focal neurological symptoms do not correspond to the localization of the underlying anatomical lesion [4, 11]. That is why there is no correlation between the primary focus and the overall neurologic deficit [9].

Constantin von Monakow: an outstanding scientist of his time



Constantin von Monakow (1853–1930)

The notion of diaschisis was introduced by the famous Russian-Swiss neurologist, neuro-anatomist and neuropsychologist Constantin von Monakow [9, 10]. He was also known as a critic of the theory of neuropsychological functions localization. Monakow (1853–1930) was born in village Bobretsovo in the Vologda province (Russia). In 1863, the family immigrated to Germany, and then in 1866 moved to Zurich (Switzerland) [12, 13]. In 1877, he graduated from the

Medical Faculty of the University of Zurich, where he conducted research on the anatomy of the brain and gave lectures on neurology [14, 15]. In 1894, Monakow became a professor and in 1891 founded the Institute of Brain Anatomy in Zurich, and later became its director. In 1917, he founded the Swiss magazine *Archive of Neurology and Psychiatry* (*Schweizer Archiv für Neurologie und Psychiatrie*) being its editor and organized Swiss Neurological Society [16].

Providing aforementioned experimental studies, Monakow was also successfully collaborating with many internationally known scientists such as neurologist-psychiatrist Vladimir Bechterev (1857–1927), the neurologist and neuroscientist Constantin von Economo (1876–1931), Cornelis Winkler (1855–1941), Jules Joseph Déjerine (1849–1917), Augusta Déjerine-Klumpke (1859–1927), Gennosuke Fuse (1880–1946), and Paul Charles Dubois (1848–1918) [12]. In 1923, von Monakow retired as professor of neurology, but still sustained to work in the Neuroanatomical Institute and his outpatient clinic [17]. Von Monakow died peacefully on October 19, 1930. He left a manuscript autobiography which was deposited in the Central Library of Zurich, where it rested for four decades. Following the death of his last surviving daughter in 1967, hundreds of letters addressed to von Monakow, his autobiographical sketches and scientific manuscripts were turned over to the Zurich Medizinhistorisches Institut [18]. Editors found all these documents to be not only of great importance for the history of medicine and science but also of great human interest. Reflections about his most interesting scientific life were published in 1970 entitled as *Vita Mea — Mein Leben* [19].

According to Luria, Constantin von Monakow was “one of the most profound and cautious neurologists of our time” [20].

Monakow concept of diaschisis

The concept of diaschisis von Monakow interpreted as “...a state of decline or absence of function after a brain trauma and an effect on the site of the nervous system that is remote from the source of damage”. Von Monakow first developed and scientifically substantiated the doctrine of

diaschisis and applied this doctrine to explain the neurological symptoms arising from damage of specific levels of the brain [3, 16]. His work was grounded on the concept the hierarchical organization of brain functioning and subordination of brain centers, developed by the Scottish neurologist John Hughlings Jackson [21].

Causes and pathophysiological mechanisms of diaschisis: a historical review

Diaschisis is a complex pathophysiological process triggered by the action of biomechanical forces or hemodynamic disorders in the brain. Disturbances, associated with diaschisis, can develop in minutes after a brain injury [10, 22].

Diaschisis is a type of shock of the central nervous system, limited only by separate anatomical and functional systems, while the other forms of shock (traumatic, apoplectic, psychogenic, infectious) to some extent complete inhibition of the cerebral cortex and the disruption of vital functions of the body [23, 24]. That is why diaschisis causes disturbance only of those anatomo-topographic levels of the nervous system with which the damaged site is connected by a system of conducting paths.

The main cause of diaschisis is the sudden cessation of the receipt of specific physiological impulses to the corresponding nerve centers of the functional system with effector functions [25].

Disruption of motility occurs during the dysfunction of the spinal cord caused by spine vertebral damage at the cervical and upper thoracic level (for instance, vertebrae dislocation or fractures of its body and arch). This damage can occur, for example, by diving in shallow water, falling head-down, striking the neck, or by sudden over-extension of the neck. In acute and subacute period traumas of the spinal cord and vertebral cord at cervical and upper thoracic level cause the following type of damage: tendon and periosteal reflex depression, muscle hypotony with flaccid paralysis of the extremities with areflexia of deep reflexes, or disturbances of all kinds of sensitivity by the conductor type [10]. These are symptoms of spinal cord function disorders, which occur during the spinal injuries, and are named a “spinal” shock [26]. Neurological deficit during a “shock of the spinal cord” is not necessarily combined with general symptoms of traumatic shock.



Henry Charlton Bastian (1837–1915)

Bastian's law, 1890

The above described symptoms of cervical and upper thoracic level damage to the spine and vertebral cords have been known for a long time. In 1890, they were analyzed by the English neurologist Henry Charlton Bastian (1837–1915) as Bastian's law — the termination of tendon and periosteal reflexes at spinal cord injury at the higher upper thoracic level [27–29]. The author considered these neurolo-

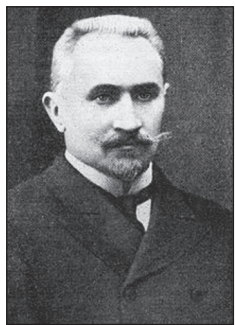
gical deficits to be regular, constant, and explained them by different mechanisms [27]:

- prolapse of hypertonic cerebellar pulses at the transection of the spinal cord;
- violation of blood and lymph circulation in the lower to the transection parts of the spinal cord;
- increased pressure of cerebrospinal fluid and damage of spinal cord roots;
- and exposure to toxins.

Further experimental and clinical studies have shown that Bastian's law has no absolute significance [30].

Lapinsky's experimental studies refuted Bastian's law

In a series of experimental studies, the professor at the University of St. Vladimir, Mykhailo Mykytovych Lapinsky, for the first time proved that



**Mykhailo
Mykytovych
Lapinsky
(1862–1947)**

the state of reflexes in the paralyzed part of the body of a patient with total spinal cord interruption was interrelated with the nature of the trauma and chronological factor [31–33]:

— a high transection of the spinal cord (in a dog) did not cause areflexia but caused revival of reflexes if the surgery was performed with due caution;

— a coarse trauma to the lower stump led to the reflex function extinction, but the reflexes were

revived again after a cautious transection of the spinal cord below the stump.

The results of Lapinsky's experimental studies, as well as clinical observations of those wounded during World War II [31–35], refuted Bastian's law about the persistent loss of appropriate reflexes in the anatomical transection of the spinal cord.

However, in most cases, with the total anatomical break of the spinal cord in humans, Bastian's law still remains valid.

Spinal diaschisis is a dynamic phase process

Spinal shock is not a simple consequence of trauma, since after restoration of reflex functions, re-cutting of the spinal cord below the level of a previous cut does not cause a spinal shock. For the pathophysiological explanation of motor disorders in patients with spinal shock, diaschisis, described by Constantin von Monakow as a dynamic phase process, is of the greatest importance [6, 10].

Spinal diaschisis (shock) is a dynamic phase process. After a certain period, the extremities' limp paralysis is replaced with a spastic one, caused by disappearance of the paralysis of the motor cells of the anterior horns of the spinal cord caused by diaschisis. The reversal of spinal diaschisis occurs on average during 4–8 weeks after trauma [10, 34].

Conclusions

Monakow was an outstanding scientist of his time. He will be remembered by his important contributions to our knowledge on the organization, location, and direction of tracts of the nervous system [12]. His concept of diaschisis is placed at the center of the understanding of brain function.

Conflicts of interests. Authors declare no conflict of interest that might be construed to influence the results or interpretation of their manuscript.

Additional information

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Author contributions: S.M. Vynychuk — study concept and design, interpretation of data, data acquisition; O.Ye. Fartushna — article concept and design, data acquisition, literature overview, interpretation of data, and drafting the article.

References

1. Finger S. *The von Monakow concept of diaschisis: origins and perspectives* / S. Finger, P.J. Koehler, C. Jagella // *Archiv Neurologie*. — 2004. — Vol. 61. — P. 283-288.
2. Carrera E. *Diaschisis: past, present, future* / E. Carrera, G. Tononi // *Brain*. — 1911. — Vol. 137 (9). — P. 2408-2422.
3. *Monakow von C. Die Lokalisation im Grosshirn und der Ablauf der Function durch kortikale Herde* / Monakow von C. — Wiesbaden: J.F. Bergmann, 1914. — 1033 s.
4. *Monakow von C. Localization of brain functions // Some papers on the cerebral cortex* / Ed. by Von Bonin G. — Springfield: Charles C. Thomas, 2008. — Vol. 159. — P. 247-251.
5. Imbrosci B., Yebrouck E., Arckens L., Mittmann T. *Neuronal mechanisms underlying transhemispheric diaschisis following focal cortical injuries* / B. Imbrosci, E. Yebrouck, L. Arckens et al. // *Brain Structure and Function*. — 2015. — 220 (3). — P. 1649-1664.
6. Engelhardt E. *Shock, diaschisis and von Monakow* / E. Engelhardt, M.M. Gomes // *Arquivos de Neuro-Psiquiatria*. — 2013. — Vol. 71. — P. 487-489.
7. Вичук С.М. *Гострий ішемічний інсульт: Монографія* / С.М. Вичук, М.М. Прокопів. — К.: Наукова думка, 2006. — 286 с.
8. Jagella C. *100 Jahre Neurologie an der Universität Zürich 1894 bis 1994 — Constantin von Monakow (1853 bis 1930)* / C. Jagella, H. Isler, K. Hess // *Schweizer Archiv für Neurologie und Psychiatrie*. — 1994. — Vol. 145 (suppl. 1). — P. 1-61.
9. *Monakow von C. Über den gegenwärtigen Stand der Frage nach der Lokalisation im Grosshirn* / C. von Monakow // *Ergebnisse der Physiologie*. — 1904. — Vol. 3 (2). — P. 100-122.
10. Вичук С.М. *Діашиз при мозговому інсульті* / С.М. Вичук. — К.: Изд-во «ОЖИВА», 2017. — 64 с.
11. *Monakow von C. Introduction Biologique a l'Étude de la Neurologie et de la Psychopathologie* / Monakow von C., R. Mourge. — Paris: Librairie Félix Alcan, 2008. — Vol. 159. — P. 247-251.

12. Sarikcioglu L. Constantin von Monakow (1853–1930) and his legacy to science / L. Sarikcioglu // *Child's Nervous System*. — 2018. — Vol. 34 (1). — P. 1-3.
13. Jagella E.C. Constantin von Monakow: ein Begr Ünder der Schweizerischen Neurologischen Gesellschaft / E.C. Jagella, H.E. Krestel // *Schweizer Archiv für Neurologie und Psychiatrie*. — 2008. — Vol. 159. — P. 247-251.
14. Kreuter A. Deutschsprachige Neurologen und Psychiater. — 1996. — Vol. 2. — P. 981-985.
15. Wiesendanger M. Constantin von Monakow (1853–1930): a pioneer in interdisciplinary brain research and a humanist / M. Wiesendanger // *Comptes rendus biologiques*. — 2006. — Vol. 329. — P. 406-418.
16. Kesselring J. Constantin von Monakow's formative years in Pfafers / J. Kesselring // *Jornal of Neurology*. — 2000. — Vol. 247. — P. 200-205.
17. Koehler P.J. Constantin von Monakow (1853–1930) / P.J. Koehler, C. Jagella // *Journal of Neurology*. — 2002. — Vol. 249. — P. 115-116.
18. Appenzeller O. Constantin von Monakow: Vita Mea. Mein Leben / O. Appenzeller // *Archives of Neurology*. — 1971. — Vol. 25 (4). — P. 382-383.
19. Monakow von C. Vita mea — Mein Leben / H.A.W. Gubser, E.H. Acker. — Huber: Bern-Stuttgart, 1970. — P. 1-323.
20. Віничук С.М. Історія Київської неврологічної школи / С.М. Віничук, О.Є. Фартушна. — К.: Едванс-Прінт, 2015. — 55 с.
21. Jackson J.H. On a case of paralysis on the tongue from haemorrhage in the medulla oblongata / J.H. Jackson // *Lancet*. — 1872. — Vol. 2. — P. 770-773.
22. Andrews R.J. Transhemispheric diaschisis — a review and comment / R.J. Andrews // *Stroke*. — 1991. — Vol. 22. — P. 943-949.
23. Віничук С.М. Діашиз и его роль в развитии рефлекторно-двигательных расстройств при мозговом инсульте / С.М. Віничук // *Український медичний часопис*. — 2013. — № 2 (94). — С. 143-147.
24. Feeney D.M. Diaschisis / D.M. Feeney, J.C. Baron // *Stroke*. — 1986. — Vol. 17 (5). — P. 817-830.
25. Віничук С.М. Судинні захворювання нервової системи: Монографія / С.М. Віничук. — К.: Наук. думка, 1999. — 250 с.
26. Arce D. Recognizing spinal cord emergencies / D. Arce, P. Sass, H. Abul-Khoudoud // *Am. Fam. Physician*. — 2001. — Vol. 64 (4). — P. 631-638.
27. Bastian H.C. Über einen Fall totaler traumatischer Zerstörung des Rückenmarkes an der Grenze zwischen Hals- und Dorsalmark / H.C. Bastian // *Archiv für Psychiatrie und Nervenkrankheiten (Berlin)*. — 1893. — Vol. 25. — P. 759-830.
28. Bastian H.C. On the neural processes underlying attention and volition / H.C. Bastian // *Brain*. — 1892. — Vol. 15. — P. 1-34.
29. Worboys M. Bastian (Henry) Charlton (1837–1915) / M. Worboys // *Oxford Dictionary of National Biography*. — Oxford: Oxford University Press, 2004.
30. Pearce J.M.S. Henry Charlton Bastian (1837–1915): Neglected Neurologist and Scientist / J.M.S. Pearce // *European Neurology*. — 2010. — Vol. 63. — P. 73-78.
31. Лапинский М.Н. Состояние рефлексов в парализованной части при тотальной перерезке спинного мозга / М.Н. Лапинский // *Вопросы нервно-психиатрической медицины*. — 1901. — Т. VI, вып. 2.
32. Лапинский М.Н. Об угнетении рефлекторных актов в парализованной части тела при сдавлениях спинного мозга в верхних отделах его / М.Н. Лапинский // *Неврологический вестник*. — 1902. — Т. X, вып. 1, 2.
33. Vynychuk S.M. Mykhailo Mykytovych Lapinsky (1862–1947) / S.M. Vynychuk // *Journal of Neurology*. — 2011. — № 258 (12). — P. 2300-2301.
34. Раздольский И.Я. Общие вопросы клиники огнестрельных ранений и повреждений позвоночника и спинного мозга // *Опыт советской медицины в Великой Отечественной войне 1941–1945 гг.* / И.Я. Раздольский. — М.: 1952. — Т. 11. — С. 72-123.
35. Раздольский И.Я. Неврологическая клиника остаточных явлений после огнестрельной травмы спинного мозга / И.Я. Раздольский // *Седьмая сессия нейрохирургического совета*. — М., 1947. — С. 180-188.

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Діашиз: короткий історичний екскурс

Резюме. *Актуальність.* У статті наведено історичний екскурс концепції діашизу Монакова. *Мета дослідження.* Вивчення та узагальнення даних наукової літератури щодо відкриття, термінологічного позначення та патофізіологічних механізмів виникнення діашизу, історії проблеми. *Матеріали та методи.* Аналітичний огляд наукових публікацій за період 1900–2018 рр. із використанням сучасних наукометричних баз даних (Scopus, Web of Science, MEDLINE, ScieLo, PubMed, The Cochrane Library, EMBASE, Global Health, CyberLeninka, RINC) та фондів наукових бібліотек України, ЄС, Великобританії та США. Серед наукових книг та статей, які були знайдені за ключовими словами, 35 дослідницьких публі-

кацій відповідали встановленим критеріям відповідності та були проаналізовані. *Результати.* Костянтин фон Монаков був швейцарським неврологом російського походження і видатним ученим свого часу, який вперше привернув наукову увагу до динамічності нервової системи, віддалених ефектів ураження мозку та відновлення його функцій. Концепція діашизу, розроблена Монаковим, є центром розуміння функціонування мозку. *Висновки.* Наведено історичний екскурс поняття діашизу, обґрунтовані патофізіологічні механізми його виникнення.

Ключові слова: діашиз; історія; походження; патофізіологія; концепція діашизу Монакова; Костянтин фон Монаков

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Дишиз: краткий исторический экскурс

Резюме. Актуальность. В статье представлен исторический экскурс концепции дишиза Монакова. **Цель исследования.** Изучение и обобщение данных научной литературы об открытии, терминологическом определении, патофизиологических механизмах возникновения дишиза, истории проблемы. **Материалы и методы.** Аналитический обзор научных публикаций за период 1900–2018 г. с использованием современных наукометрических баз данных (Scopus, Web of Science, MEDLINE, ScieLo, PubMed, The Cochrane Library, EMBASE, Global Health, CyberLeninka, RINC) и фондов научных библиотек Украины, ЕС, Великобритании и США. Среди научных книг и статей, которые были найдены по ключевым словам, 35 исследовательских публикаций отвечали установленным кри-

териям и были проанализированы. **Результаты.** Константин фон Монаков был швейцарским неврологом российского происхождения и выдающимся ученым своего времени. Он впервые привлек научное внимание к динамичности нервной системы, отдаленным эффектам поражения мозга и восстановлению его функций. Концепция дишиза, разработанная Монаковым, является центром понимания функционирования мозга. **Выводы.** Представлен исторический экскурс открытия дишиза, обоснованы патофизиологические механизмы его возникновения.

Ключевые слова: дишиз; история; происхождение; патофизиология; концепция дишиза Монакова; Константин фон Монаков