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Classification of pontine infarctions

Abstract. Background. A pontine stroke is challenging to diagnose because of the complexity of presenting symptoms, clinical evaluation, diagnostic testing, and management strategy. Little is published about the classification of pontine stroke. We aimed to provide a narrative review of the classification of pontine stroke. **Materials and methods.** A comprehensive electronic literature search was performed on Scopus, Web of Science, MEDLINE, SciELO, PubMed, The Cochrane Library, EMBASE, Global Health, CyberLeninka, RINC databases, and databases of government scientific libraries of Ukraine, European Union, United Kingdom, and the USA. It was done to identify scientific publications that discussed the classification of pontine stroke. **Results.** A narrative review of the classification of pontine stroke is presented and discussed. **Conclusions.** We provided a comprehensive narrative review of the classification of pontine stroke.

Keywords: posterior stroke; classification; pontine stroke; vertebrobasilar stroke; review

Introduction

Pontine infarctions (PI) cause a varied range of symptoms and are difficult to diagnose [1]. They can range from the classical crossed syndrome, the less common pure motor hemiparesis/hemiplegia, or pure sensory stroke to respiratory and cardiac dysfunction, decreased consciousness, and the rare condition known as a locked-in syndrome [2–4]. Early diagnosis is critical as PI is associated with high mortality and morbidity [5–7]. An adequate understanding of anatomy, clinical presentation, and classification is required for evaluating and managing the disease [8, 9]. This article reviews the classification of pontine infarctions.

The purpose was to provide a narrative review of the classification of pontine stroke.

Materials and methods

A comprehensive electronic literature search was conducted on Scopus, Web of Science, MEDLINE, SciELO, PubMed, The Cochrane Library, EMBASE, Global Health, CyberLeninka, RINC databases, and databases of government scientific libraries of Ukraine, European Union, Uni-

ted Kingdom, and the USA. It was performed to identify scientific publications that discussed the classification of pontine stroke. The applicable articles are cited and referenced. No limit is placed on publication time or the language of the article. All relevant articles were identified and screened by three authors (MP, SYe, OF), and disagreements were resolved by consensus. The results are summarized narratively.

Results and discussion

It is known that pons (i.e., pons Varolii) belongs to the middle vascular and anatomical area of the posterior circular territory [10, 11]. The infarctions in pons Varolii are the most common among ischemic strokes of the brainstem [12]. They might be isolated (with ischemic foci in the pons) and/or *combined* (manifested in simultaneous pontine and extra-pontine lesions of the cerebellum or other structures of the posterior circulation territory). The most common causes of isolated PI are lesions of the basal artery (BA) branches, long and short circumflex arteries (43 %), lesions of small paramedian arteries (34 %), and less often — occlusion of BA (21 %) [13].

Eponymous classification

The first classification of PI (Dejerine J., 1914) [14] was based on the existing information at that time about so-called classical pontine syndromes [15, 16]:

— *Millard-Gubler caudal ventral pontine syndrome* is one of the classical brainstem-crossed syndromes caused by a unilateral lesion in ventral pons manifesting in ipsilateral peripheral paresis of facial muscles and heterolateral central hemiparesis [17];

— *Foville caudal tegmental pontine syndrome* is a peripheral paresis of the muscles innervated by the afferent and facial nerves on the affected side, with contralateral central hemiparesis [18];

— *Raymond-Céstan rostral tegmental pontine syndrome* debuts with homolateral paresis of the eye in combination with hemihypesthesia and hemiataxia on the opposite side [19].

Subsequently, the territories of the ventral, lateral, and dorsal pontine arteries were identified [20, 21]. This information has been summarized and expanded by other authors [22, 23].

Anatomical classification

Given the relatively rare incidence of classical pontine alternating syndromes, a new classification instead of the eponymous classification of pontine infarctions was proposed. It took into account the areas of pons arteries, highlighting ventral caudal, mid-pontine, and tegmental syndromes.

Ventral caudal pontine infarction debuts with contralateral motor hemiparesis or hemiplegia caused by the decreased blood flow in the paramedian perforating arteries arising from the basilar artery.

Mid-pontine base infarction arises due to decreased blood flow in the paramedian arteries or the short circumferential arteries arising from the basilar artery. Various combination of these symptoms results in distinct syndromes like pure motor hemiparesis (lacunar infarcts of the corticospinal tract), ataxic hemiparesis (lacunar infarcts of the pontine nuclei), dysarthria-clumsy hand syndrome (dysarthria, dysphagia, impaired dexterity and weakness of hand), and rare presentations like dysarthria-dysmetria and dysarthria-facial paresis.

Tegmental pontine syndrome can affect various structures, including cranial nerve (trigeminal, abducens, facial, and vestibulocochlear) nuclei, medial lemniscus, medial longitudinal fasciculus, respiratory centers, and the pontine reticular formation.

The existence of isolated PI was also confirmed by C.M. Fisher, who described the syndromes of pure motor hemiparesis, ataxic hemiparesis, dysarthria, and clumsy hand in patients with lacunar pontine infarcts caused by occlusion of small branches of BA [24–27].

At the end of the twentieth century and the beginning of the twenty-first century, clinical CT and MRI studies aimed to describe individual symptoms, clinical and radiological manifestations of isolated PI. This expands an understanding of the anatomical-neurological correlation of PI clinical course. In particular, it was shown [28] that

PI can occur in the intramural segment of penetrating branches of the dorsal part of BA. In a publication of a later period [29], the author described impaired sensitivity of the face by segmental dissociated type, motor disorders such as pure motor hemiparesis in patients with PI. In addition, hemiparesis may recur repeatedly over several days. Such transient hemiparesis was named “herald hemiparesis” and might indicate occlusion of BA [30, 31]. In the case of PI located in the rostral part of the pons, dysmetria and ataxia of the contralateral extremities occur. If PI is localized closer to the midline of the pons, bilateral ataxia occurs due to lesions of the corticopontine and pontocerebellar pathways [32–34].

J.S. Kim and co-authors (1995) [35] studied the clinical manifestations of acute PI and determined the correlation of clinical syndromes with the results of neuroimaging. Among the 37 examined patients, 17 (46 %) had a clinical picture of pure motor hemiparesis or hemiplegia, 3 (8 %) had sensorimotor hemiparesis, 4 (11 %) had ataxic hemiparesis, and 6 (16 %) had dysarthria syndrome and a clumsy hand. One patient (3 %) had dysarthria-hemiataxia as a variant of ataxic hemiparesis, two (5 %) had quadrataxic paresis and four (11 %) had dysarthria syndrome — facial paresis as a variant of a dysarthria syndrome and a clumsy hand. Various lacunar syndromes are caused by lesions of the corticospinal, corticonuclear, corticopontine, and pontocerebellar tracts.

Even in MRI-positive PI cases, stroke symptoms might be transient, lasting from seconds to 24 hours, causing so-called mini-stroke or transient ischemic attack [36–41]. The duration of the symptoms should be considered by the physicians while diagnosing and managing PI as 7–40 % of patients experience a TIA before a stroke [42–45]. About one third of people who have a TIA go on to have a more severe stroke within one year [46, 47]. According to the lesion shapes and locations, isolated PI might be two types: paramedian and lacunar, i.e., small deep PI [48, 49].

Taking into account the classification and clinical presentation of PI, a prompt diagnosis, adequate therapeutic approach, and educational programs for the prevention of transient ischemic attacks and/or stroke have to be applied promptly, reducing disability and mortality and improving the quality of life of these patients [50–56].

Conclusions

Classifications of PI are extremely important in clinical practice when making a design about a patient’s diagnosis, management, and prognosis. We provided a comprehensive narrative review of the anatomical and etiological classification of PI.

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Класифікація мостових інфарктів

Резюме. Актуальність. Мостові інсульти є складними в діагностиці і, порівняно з півкульними інсультами, мають гірший прогноз та перебіг. Проте мало наукових праць опубліковано про класифікацію мостових інсультів. Ми прагнули надати місткий та короткий огляд наукової медичної літератури щодо класифікації мостових інсультів.

Матеріали та методи. Проведено комплексний електронний пошук літератури у базах даних Scopus, Web of Science, MEDLINE, SciELO, PubMed, The Cochrane Library, EMBASE, Global Health, CyberLeninka, RINC, а також у ба-

зах даних державних наукових бібліотек України, Європейського Союзу, Великобританії, США з метою виявлення наукових публікацій, у яких обговорювалася класифікація мостових інсультів. **Результати.** Наведено та обговорено огляд наукової медичної літератури про класифікацію мостових інсультів. **Висновки.** Ми надали докладний огляд класифікації мостових інсультів.

Ключові слова: інсульт у басейні задньої мозкової артерії; класифікація; мостовий інфаркт; вертебробазиллярний інсульт; огляд