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Shock, diaschisis and von Monakow

Choque, diásquise e von Monakow

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ABSTRACT

The concept of shock apparently emerged in the middle of the 18th century (Whyett) as an occurrence observed experimentally after spinal cord transection, and identified as "shock" phenomenon one century later (Hall). The concept was extended (Brown-Séquard) and it was suggested that brain lesions caused functional rupture in regions distant from the injured one ("action à distance"). The term "diaschisis" (von Monakow), proposed as a new modality of shock, had its concept broadened, underpinned by observations of patients, aiming at distinguishing between symptoms of focal brain lesions and transitory effects they produced, attributable to depression of distant parts of the brain connected to the injured area. Presently, diaschisis is related mainly to cerebrovascular lesions and classified according to the connection fibers involved, as proposed by von Monakow. Depression of metabolism and blood flow in regions anatomically separated, but related by connections with the lesion, allows observing diaschisis with neuroimaging.

Key words: shock, spinal shock, diaschisis, neuroimaging.

RESUMO

O conceito de choque aparentemente surgiu em meados do século 18 (Whyett), como ocorrência observada experimentalmente após seção transversa da medula, e foi identificado como fenômeno de "choque" um século mais tarde (Hall). O conceito foi estendido (Brown-Séquard) e sugeriu-se que lesões cerebrais produziam ruptura funcional em regiões distantes à da lesão ("action à distance"). O termo "diásquise" (von Monakow), proposto como nova modalidade de choque, teve seu conceito ampliado, fundamentado em observações em pacientes. Visava distinguir sintomas de lesões cerebrais focais de efeitos transitórios que produziam, atribuíveis à depressão de partes distantes do cérebro conectadas à área lesada. Atualmente, diásquise é relacionada principalmente a lesões cerebrovasculares e classificada de acordo com as fibras de conexão envolvidas, como proposto por von Monakow. Depressão do metabolismo e fluxo sanguíneo em regiões anatomicamente separadas, mas relacionadas por conexões à lesão, permitem observar diásquise por meio de neuroimagem.

Palavras-Chave: choque, choque espinhal, diásquise, neuroimagem.

The diaschisis concept designates a transitory neurological manifestation after a lesion, and was preceded by the notion of shock. Clinically, its use was maintained over the years and, more recently, came out a revival with the advent of modern neuroimaging techniques, which allowed for an objective and non-invasive demonstration of the phenomenon in man. These views are related to functional recovery in an ample sense; therefore, it is appropriate to be familiar with some historical steps on shock and diaschisis.

ON SHOCK AND BEYOND

Robert Whyett (1714–1766) had the opportunity to observe in 1750, in his experimental studies on reflexes, a phenomenon he described as follows: "[...] a loss of sensation accompanied by motor paralysis with initial loss but gradual recovery of reflexes, following a spinal cord transection [...]". This description was most likely the forerunner of the notion of shock, as applied to the nervous system. However, the researcher didn't assign a specific term to this occurrence[1].

Almost one century later, Marshall Hall (1790–1857), in his studies of excito-motor reflex action, described several experiments in laboratory animals, such as: "[...] 19. Exp. 2. If we divide the spinal marrow just below the occiput, all these phenomena cease: there is no longer an attempt to escape on being touched; there are no spontaneous movements [...] 20. Exp. 3. But certain other phenomena are observed: at first, indeed, when I prick or pinch the toes with the probe or forceps, there is no movement; but very shortly each of such excitations followed by distinct and energetic movements of the limb [...] 21. The first of these phenomena, the absence

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of reflex action on the application of excitants, is owing to the 'shock' inflicted by the division of so vital an organ [...] as this shock gradually subsides, the movements induced by excitation are more and more energetic [...]". Hall observed similar aspects in patients who suffered spinal cord (paraplegia) and brain (hemiplegia) lesions he examined clinically[1,2].

This notion of (neural) shock was accepted and further extended to the brain. The researchers that made cardinal contributions to this issue will be highlighted.

Charles-Édouard Brown-Séquard (1817–1894), besides his studies of the symptoms manifest by hemisection of the cord (1849)[3], showed strong interest on localization and recovery of brain functions, with a dynamic view and based on the principles of distant action ("action à distance") (1875). He assumes that the nervous system is an aggregate of nine disseminated organs, that necrosis of one part of an organ temporarily inhibits distant element of the organ, and the release of inhibition of these undamaged distant elements results in recovery (1873–1890)[4]. It can be said that he was a predecessor of the concept on remote effects of focal brain lesion.

ON DIASCHISIS

Constantin von Monakow (1853–1930) build-up more fully such ideas, but it is not certain his familiarity with earlier studies. von Monakow observed clinically that the initial symptoms of patients were not necessarily the same as the later and final neurological impairment. The opening functional picture, he declared, was an instantaneous one, the lasting impairment could be attributed to functional reaction of the individual organism and its final status was only possible to be assessed after a period of time. This led von Monakow to introduce the term "diaschisis" (1902), elaborated in his further writings (1905–1928). He stated: "The nervous tissue, when it suffers an injury, manifests a series of phenomena that can be grouped under the designation of "diaschisis" (separated at distance)." The term comes from the Greek *diaschizein* ("to severe"), composed by *=[dia]+schizein=schizein* ("to split", intended to mean "separation" or "splitting")[5-8].

von Monakow considered diaschisis as representing a special form of shock that occurs usually, but not necessarily, in a sudden way, following a focal lesion, and its progress follows the long fibers that originate at the focus and its surroundings. He exemplifies with a cortical lesion of the central gyrus resulting in hemiplegia, and details that, besides the damage of the cortico-spinal system, other numerous neurons that give rise to intercortical fibers are also destroyed. The shock effect, according to the author, is transmitted along all these systems to the regions where the fibers terminate, functionally disordering or putting them out of action for a variable time[4,5,7,8] (Table 1).

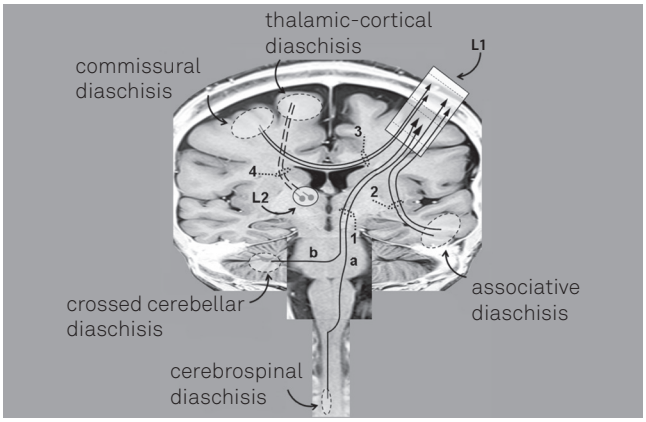
Thus, the fibers affected by the original lesion, related to various neuronal systems, spread the diaschisis effect along cortical-subcortical connections, as well as along intercortical ones, that relate near and distant parts of the cortex of the same (intrahemispheric association fibers) and of the opposite hemisphere (interhemispheric commissural fibers [corpus callosum])[4,7-9] (Table 2 and Figure).

Table 1. Aspects of diaschisis emphasized by von Monakow[4,5,7].

(i) Damage to one brain area can, by loss of excitation, produce cessation of function in regions adjacent to, or remote from, but connected to the primary site of damage.
(ii) Diaschisis is a clinical diagnosis whose presumptive mechanism is loss of excitation to intact regions rather than neural inhibition.
(iii) Diaschisis "undergoes gradual regression in well defined phases" such that resolution will parallel resumption of function in areas of diaschisis.
(iv) The "wave of diaschisis" follows neuroanatomical pathways spreading from the site of injury.

Table 2. Types of diaschisis according von Monakow with updated information[4,7-10].

(a) Diaschisis corticospinalis (or cerebrospinalis)
Functional depression from a motor cortex injury to the spinal cord along pyramidal tract fibers.
Later, a cortical-cerebellar diaschisis was also recognized, along cortical-pontine-cerebellar fibers.
(b) Diaschisis associativa
Intrahemispheric: cortical suppression of other cortical areas via corticocortical association fibers.
Later, a thalamic-cortical diaschisis was also described via thalamic-cortical fibers.
Interhemispheric (diaschisis commissuralis or corticocommissuralis): cortical injury of one hemisphere can produce contralateral functional depression of the other hemisphere via fibers of the corpus collosum.



L1: cortical lesion [inset with magnified view of the cerebral cortex], L2: thalamic lesion, 1: projection fibers [a: corticospinal, b: cortical-pontine-cerebellar], 2: associative intrahemisferic fibers [cortical-cortical], 3: associative interhemispheric or commissural fibers (corpus callosum), 4: thalamic-cortical fibers. The sites of lesion (L1 and L2) and of diaschisis are represented over a coronal magnetic resonance image (composite and distorted), based on von Monakow's drawings[6,9] and additional information[4,10].

Figure. Types of diaschisis after a focal cortical lesion.

Von Monakow affirms that: "The concept of diaschisis is the basis of the fundamental distinction, in experimental physiology and in human clinics, between (a) the initial or temporary symptoms (domain of diaschisis proper) and (b) the permanent or residual symptoms (domain of the secondary anatomical degenerations proper). The temporary symptoms have a fairly typical character in lesions of certain parts of the brain and, just as regularly as they come, they will go away again hours or days, generally after a longer time, even when the focus remains stable"[7,8].

The basic proposal that emerged from von Monakow's ideas was that damage to one part of the brain must have disruptive effects on other parts, which may later wear off and be associated with some recovery of function. Thus, he established the differentiation between localization of function and localization of symptoms[5,6].

DIASCHISIS NOWADAYS

The concept of diaschisis continued to be used in clinical scenario over the years. With the advent of modern non-invasive neuroimaging techniques, the concept found new support, as they allow showing the depression of regional neuronal metabolism or cerebral blood flow in a given region connectively related to the injured site. Diaschisis has largely been studied in vascular brain lesions (and traumatic ones, as well), following roughly von Monakow's description (Table 2), including thalamic-cortical or cortical-subcortical (intrahemispheric), transcallosal in the opposite hemisphere (interhemispheric), the frequent crossed cerebellar, among others. Regression of the diaschisis effect might explain the clinical, neuropsychological and neuroimaging changes observed over the first few months after a stroke (or trauma), and such information have been used in association with studies on rehabilitation[9,10].

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