Pial vessel

The pial vessels are intracranial vessels on the surface of the brain within the pia–arachnoid (also known as the leptomeninges) or glia limitans (the outmost layer of the cortex comprised of astrocytic end-feet) [1].

Pial vessels are surrounded by cerebrospinal fluid (CSF) and give rise to smaller arteries that eventually penetrate into the brain tissue.

Penetrating arterioles lie within the Virchow Robin space and are structurally between pial and parenchymal arterioles.

The penetrating arteries become parenchymal arterioles once they penetrate into the brain tissue and become almost completely surrounded by astrocytic end-feet [2] [3].

There are several important structural and functional differences between pial arteries on the surface of the brain and smaller parenchymal arterioles. First, pial arteries receive perivascular innervation from the peripheral nervous system also known as “extrinsic” innervation, whereas parenchymal arterioles are “intrinsically” innervated from within the brain neuropil.

While parenchymal arterioles have only one layer of circumferentially oriented smooth muscle, they possess greater basal tone and are unresponsive to at least some neurotransmitters that can have large effects on upstream vessels (e.g., serotonin, norepinephrine) [4].

It is currently accepted that intracranial pain-sensitive structures are limited to the dura mater and its feeding vessels and that small cerebral vessels and pia mater are insensitive to pain, which is inconsistent with some neurosurgical observations during awake craniotomy procedures.

Fontaine et al. prospectively collected observations of painful events evoked by mechanical stimulation (touching, stretching, pressure, or aspiration) of intracranial structures during awake craniotomies, routinely performed for intraoperative mapping to tailor brain tumour resection in the eloquent area. Intraoperatively, data concerning the locations of pain-sensitive structures were drawn by the surgeon on a template and their corresponding referred pain was indicated by the patient by drawing a cross on a diagram representing the head. Ninety-three painful events were observed and collected in 53 different patients (mean age 41.2 years, 25 males) operated on awake craniotomy for left (44 cases) or right (nine cases) supra-tentorial tumour resection in eloquent areas. On average, 1.8 painful events were observed per patient (range 1-5). All the painful events were referred ipsilaterally to the stimulus. In all cases, the evoked pain was sharp, intense and brief, stopped immediately after termination of the causing action, and did not interfere with the continuation of the surgery. In 30 events, pain was induced by stimulation of the dura mater of the skull base (23 events) or of the falx (seven events) and was referred predominantly in the V1 territory and in the temporal region. In 61 cases, pain was elicited by mechanical stimulation of the pia mater or small cerebral vessels of the temporal (19 events), frontal (25 events), parietal (four events) lobes and/or the peri-sylvian region, including the insular lobe (13 events), and referred in the V1 territory. In this observational study, we confirmed that dura of the skull base and dura of the falx cerebri are sensitive to pain and that their mechanical stimulation induced pain mainly referred in the sensory territories of the V1 and V3 divisions of the trigeminal nerve. Unlike earlier studies, Fontaine et al. observed that the pia and the small cerebral vessels were also pain-sensitive, as their mechanical stimulation induced pain referred mainly in the V1 territory. These observations suggest that small

pial cerebral vessels may also be involved in the pathophysiology of primary and secondary headaches [5].

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