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MORPHOLOGICAL ASPECTS OF THE DISTAL MEDIAL STRIATED ARTERY (ARTERY OF HEUBNER)

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ABSTRACT

The distal medial striated artery, one of the branches of the anterior complex of the circle of Willis, is important because it supplies the caudate nucleus and adjoining putamen, part of the septal nucleus and fibers of the anterior part of the internal capsule. This vessel situated in a region often dealt with in neurological surgeries and can be injured because of its anatomical relationship with important structures in this region. In this study, we examined the anatomical arrangement in 50 human brains fixed in 20% formaldehyde solution. The origin of this vessel was assessed relative to the pre-, post- and communicating segments of the anterior cerebral artery. Of the 121 arteries found, 49.6% arose from the post-communicating segment and were duplicated in 50.4% of the cases, single in 49.6% and symmetrical in 44.5%. The distal medial striated artery was absent in only one specimen. In relation to the pre-communicating segment, the course of this artery was anterior in 77% of the cases, superior in 20% and posterior in 3%. A division of the anterior perforated substance into anterior, lateral and medial regions served to locate the terminal branches of the artery. The terminal branches penetrated the anterior, lateral and medial regions in 48.8%, 47% and 4.3% of the cases respectively.

Key words: Anterior cerebral artery, cerebral blood supply, circle of Willis, distal medial striated artery, perforating arteries

INTRODUCTION

The distal medial striated artery or artery of Heubner, which originates from the anterior cerebral artery belongs to the anterior part of the arterial circle of the brain, and is of considerable anatomic importance because it supplies the caudate, putamen and anterior part of the internal capsule. Several studies have described the anatomy of the anterior cerebral complex involving the distal medial striated artery [1-5,7,10,12,14-16]. These reports were based on formalin-fixed specimens [10,12], or on perfusion techniques using India ink or gelatin [12,14], vinyl acetate and polyester resins [6,7,12], or plastic resin radiopaque substances [17], as well as on clinical cases and neuroimaging [2,13].

Clinical studies have shown that the most arterial obstructions and hypoplastic events occur in the pre-communicating segment of the anterior cerebral artery [15]. Critchley [2] demonstrated a correlation between anatomy and the clinical findings in a case in which the infarct in the territory of the distal medial striated artery resulted in aphasia and paresis of the upper limb, face and tongue on the side opposite to the lesion. Miller *et al.* [13] described a case in which a supposed congenital infarct in a child resulted in contralateral motor symptoms that were traced to the territory of the distal medial striated artery. The morphological, anatomical and functional complexity of the distal medial striated artery, in relation to the structures of the central nervous system and the advances of new techniques in vascular neurosurgery highlight the need for a better understanding of the anatomy of this vessel. In this work we describe the anatomical arrangement of the distal medial striated artery (DMSA) based on a series of 50 formaldehyde fixed human brains.

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MATERIAL AND METHODS

Fifty brains from adult cadavers fixed in 20% formaldehyde solution were used to study the distal medial striated artery (DMSA). In one of the brains, the arteries had previously been injected with latex through the basilar artery. The origin, course, relationship to the anterior cerebral artery, position of the terminal branch endings and duplicity of the DMSA were studied by dissection using a stereomicroscope. To determine the vessel's origin, the anterior cerebral artery was divided into pre-, post-

and communicating segments. The degree of symmetry was also examined. The reference points for penetration of the terminal branches into the anterior perforated substance were based on the anatomical arrangement of the anterior cerebral, middle and posterior communicating arteries. This arrangement allowed a division of the anterior perforated substance into anterior, medial and lateral regions which included the anterior and middle cerebral arteries, the anterior cerebral and communicating posterior arteries, and the middle and posterior communicating arteries, respectively. Photographic contrast of the arteries was improved by manually coloring the vessels.

RESULTS

The DMSA occurred in all brains examined and arose from the anterior complex of the arterial circle of the brain, with a variable distribution thereafter. One hundred and twenty-one arteries were found, of which 50.4% were single and 49.6% were duplicated. Of the duplicated DMSAs, 80% had a double origin, whereas 20% arose from a single trunk. In 49.6% of the cases, the DMSA arose from the post-communicating segment, in 43.8% from the communicating segment and in 5.8% from the pre-communicating segment. In 0.83% of the cases, the DMSA arose from a common trunk with the orbitofrontal artery. A symmetrical origin was found in 44.5% of the searched brains. When the beginning of the DMSA was related with the surface of the parent vessel, the frequency was of 78.5%, 18.2% and 3.3% for the lateral, superior and inferior surfaces, respectively. In relation to the pre-communicating segment, the DMSA had an anterior course in 77%, superior course in 20% and posterior course in 3% of the cases. The terminal branches penetrated the anterior, medial and lateral regions of the perforated substance in 48.8%, 4.3% and 47% of the cases, respectively. The branches were single in 58.7% of the cases, double in 35.5% and triple in 5.8% of the cases. Figure 1 shows some morphological aspects of the DMSA.

DISCUSSION

The greatest variation in the anatomy of the DMSA was observed in its origin. Critchley [2] and De Almeida [3] described the artery arising from the anterior communicating, internal carotid, middle cerebral and anterior cerebral arteries. Perlmutter and Rhoton [15] described its origin from the post-communicating (78%) and pre-communicating (14%) segments of the anterior cerebral artery. Ahmed and Ahmed [1], Kaplan [7] and Westberg [17] described the anterior communicating artery as the main origin of the DMSA. Marinkovic *et al.* [12] observed the artery arising from the post-communicating segment (21%), from the anterior communicating artery (17%), from the pre-communicating segment (4%), from the post-communicating azigo segment (4%) and from a fenestration of the pre-communicating segment in 8% of the cases. Gomes *et al.* [6] described only one DMSA arising from the orbitofrontal artery.

Our findings on the origin of the pre-communicating segment as a source of the DMSA agreed with the findings of Gomes *et al.* [6] and Marinkovic *et al.* [12]. However, our results for the post-communicating segment differed from those of Gomes *et al*. [6], Marinkovic *et al.* [12] and Perlmutter and Rhotton [15]. Thus, the DMSA arose from the communicating segment more often (43.8%) than reported by Gomes *et al.* [6] (17%) and Marinkovic *et al.* [12] (35%). Only one DMSA arose from the orbitofrontal artery, which agrees with the findings of Gomes *et al*. [6]. We found no DMSA originating from the internal carotid, middle cerebral or frontopolar arteries, in contrast to Critchley [2], Gomes *et al.* [6] and Marinkovic *et al*. [12]. Gomes *et al.* [6] found no DMSA arising from the lower surface of the main vessel, whereas this occurred in 3.3%.

The frequency of duplicity observed here was greater than in other studies, i.e. 49.6% compared to 1-12% [6,15,18]. Marinkovic *et al.* [12] mentioned that duplicity of this artery was associated with variations or malformations in other vascular segments, including hypoplasies, fenestration of the anterior cerebral artery and aneurysm of the pericallosal artery. Perlmutter and Rhotton [15] described contralateral duplicity when the DMSA was absent. We found neither malformations nor contralateral duplicity, and only one brain had no DMSA.

Symmetry was detected by Gomes *et al.* [6] in 30% of their cases and Yasargil and Smith [18] described symmetry in 85% of cases compared to our frequency of 44.5%. This discrepancy may reflect the fact that Yasargil and Smith [18] examined this vessel during surgical procedures. Gomes *et al.* [6] described that the superior course was more frequent (63%) than the anterior (34%) and posterior (3%) courses. We found frequencies of 77%, 20% and 3% for the anterior, superior and posterior courses, respectively. Such variations lead to problems during surgical procedures [6]. Westberg [17] reported difficulties in identifying the DMSA in angiography because of variations in its course and origin.

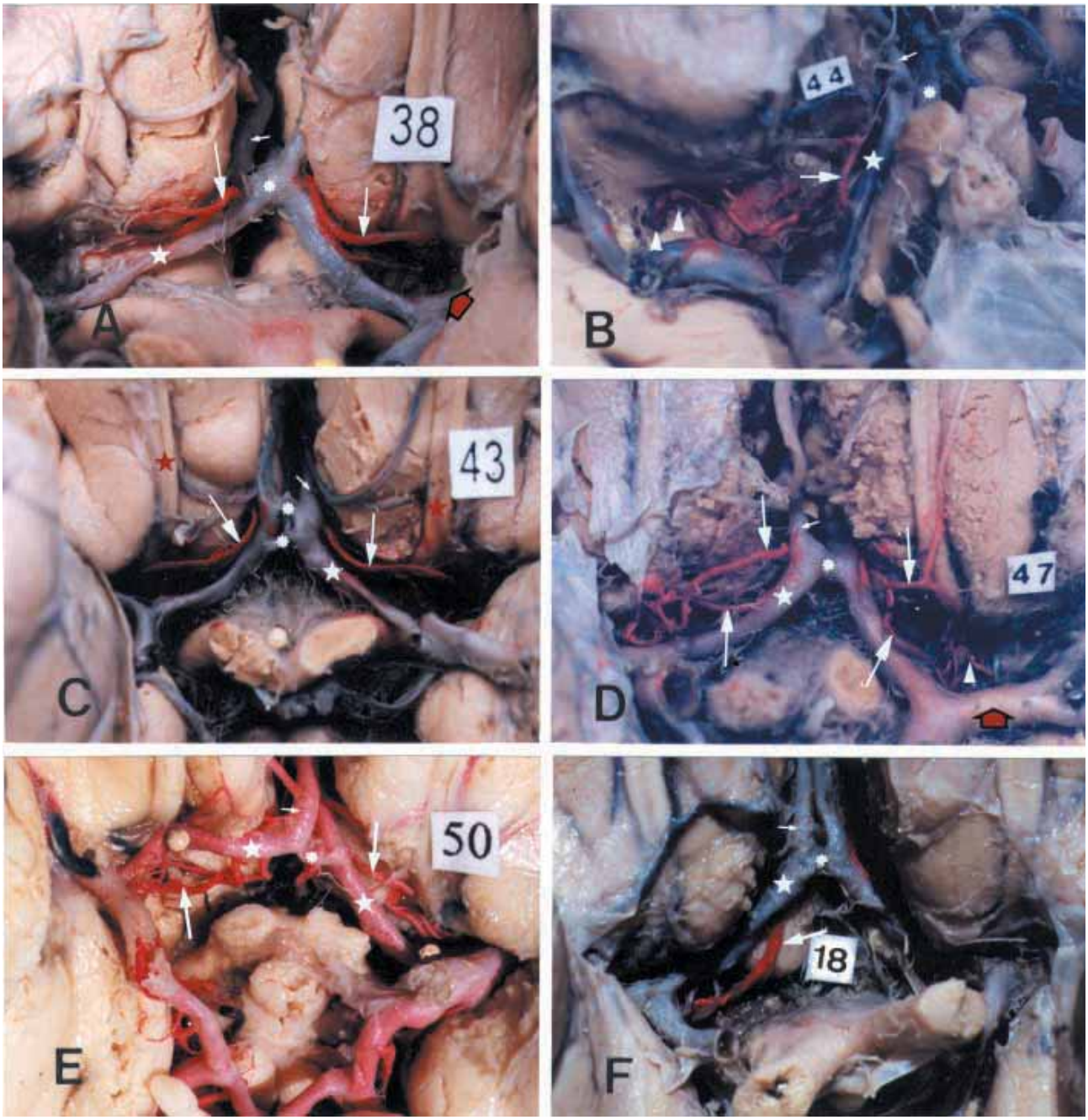

Figure 1. Morphological aspects of the distal medial striated artery. Variations in its origin and course in relation to the pre-communicating segment of the anterior cerebral artery and terminal branches. White arrows = distal medial striated artery, Star = pre-communicating segment, Asterisk = anterior communicating segment, Small white arrows = post-communicating segment, Red arrow = middle cerebral artery, **A** - Double artery arising in a single trunk from the communicating segment and anterior course. **B** - Terminal branches arrows heads penetrating the lateral region of the anterior perforating substance. Note the origin in the pre-communicating segment. **C** - Anterior course of the artery originating from the communicating segment. Note the bilateral symmetry. **D** - Bilateral double origin, anterior course and terminal branches in the anterior region of the anterior perforating substance. **E** - Superior course and origin from the post-communicating segment. **F** - Posterior course.

The terminal branches have been described as penetrating the anterior, lateral and medial regions of the perforated substance, laterally to the optic chiasm. Our results of 48.8% and 47% for the frequencies of terminal branches found in the anterior and lateral regions, respectively, were comparable to the values reported by Perlmutter and Rhotton [15]. Marinkovic *et al.* [12] stated that the DMSA often had two (17%),

three (18%) and four (12%) terminal branches. No quadruple terminal branches were observed in our series.

In conclusion, the DMSA originated most frequently in the communicating segment. The discrepancies between our results and those in the literature may be related to the different techniques used, such as anatomical dissection, replication with polyester resins [6] and selective injection with a gelatin-India ink mixture or radiocontrast substances [12,14].

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