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ORIGINAL COMMUNICATION

Callosal Branches of the Anterior Cerebral Artery: An Anatomical Report

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Although the morphology of the corpus callosum is well defined, the arterial supply of this structure has not been comprehensively studied. To elucidate this further, 40 cerebral hemispheres from 30 adult cadaveric brains were obtained. The anterior cerebral arteries were cannulated and injected with red latex. The following were observed and documented: (1) the number, diameter, and course of the arteries supplying the corpus callosum; (2) the territories vascularized by these arteries; (3) any variations of the callosal arteries. Short callosal arteries were present in 58 hemispheres (96.6%) and supplied the superficial surface of the corpus callosum along its midline and were a primary arterial source to this structure. Long callosal arteries were found in 28 hemispheres (46.6%) and contributed to the pial plexus. The cingulocallosal arteries were present in all hemispheres and supplied the corpus callosum, cingulate gyrus, and also contributed to the pericallosal pial plexus. The recurrent cingulocallosal arteries were present in 17 hemispheres (28.3%) and also contributed to the pericallosal pial plexus. The median callosal artery, an anatomical variation, was present in 10 brains (33.3%). This vessel supplied the corpus callosum and the cingulate gyrus. The aim of the present study was to provide a detailed description of the arteries supplying the corpus callosum for those who encounter these vessels radiologically or surgically. Clin. Anat. 21:383–388, 2008.

Key words: **corpus callosum; callosal arteries; anterior cerebral artery anatomy**

INTRODUCTION

The blood supply to the corpus callosum has been studied by several authors (Koshi et al., 1997; Goncalves-Ferreira et al., 2001; Suganthy et al., 2003). The callosal arteries originate from the pericallosal artery, the portion of the anterior cerebral artery located distal to the anterior communicating artery (ACoA). They provide the primary blood supply to the corpus callosum (Perlmutter and Rhoton, 1978; Gomes et al., 1986; Ture et al., 1996; Kakou et al., 2000; Rhoton, 2002; Ugur et al., 2006). Surgical approaches to the corpus callosum and pericallosal artery are difficult due to the deep location of these structures (Dickey et al., 1992; Traynelis and Dunker, 1992; Kawashima et al., 2003; Duffau et al., 2004). Coagulation of callosal arteries during

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TABLE 1. The Occurrence, Number, and Diameter of the Arteries Supplying the Corpus Callosum

			Number		Diameter (mm)	
$N = 40$	Occurrence	%	Range	Average	Range	Average
Short callosal artery	58 hemisphere	96.6	0–4	1.1	0.10–0.25	0.19
Long callosal artery	28 hemispheres	46.6	0–2	0.8	0.37–1.06	0.54
Cingulocallosal artery	60 hemispheres	100	2–20	8	0.17–0.61	0.27
Recurrent cingulocallosal artery	17 hemispheres	28.3	0–3	1.5	0.21–0.49	0.32
Median callosal artery	10 brains	33.3	1	1	0.50–1.97	1.28

surgical maneuvers may cause permanent or transient disconnection syndromes in patients (Goncalves-Ferreira et al., 1995; Lawton et al., 1996; Winkler et al., 2000; Lozier and Bruce, 2003). Surgically, knowledge of such vascular anatomy with its possible variations would be important, for example, in transcallosal approaches to the lateral and third ventricles, in treating aneurysms of the distal anterior cerebral artery, for removing tumors of the corpus callosum, and during callosotomy for medically refractory epilepsy. This study aimed to provide detailed information on the callosal branches of the pericallosal artery.

MATERIALS AND METHODS

Forty cerebral hemispheres from 30 adult cadaveric brains were obtained. Brains having signs of central nervous system trauma or disease were excluded. The anterior cerebral arteries were cannulated and injected with red-colored latex. The brains were then fixed in formaldehyde. The dissections were carried out using microsurgical instruments and a surgical microscope (Zeiss Opmi 9FC, Oberkochen, Germany). The following information was obtained: (1) the number, the diameter, and the course of the arteries supplying the corpus callosum, (2) the territories vascularized by these arteries, and (3) their variations. All measurements were made using digital calipers.

RESULTS

In our study, the main arteries supplying the corpus callosum (Table 1) were the short and long callosal arteries and the cingulocallosal and recurrent cingulocallosal arteries, which all originated from the pericallosal artery; and median callosal arteries that were found to arise directly from the anterior communicating artery. We classified the arteries of the corpus callosum as follows.

Short Callosal Arteries

Short callosal arteries were present in 96.6% of hemispheres as small, thin, and short branches. The average number was 1.1 (0–4) for each hemisphere. The mean diameter of these arteries at their origin was 0.19 mm (range: 0.10–0.25 mm) (Figs. 1 and 2). When present, they originated from the inferolateral surface of the pericallosal artery in all hemispheres. After originating from the pericallosal artery, they penetrated the corpus callosum in the midline and continued to supply the indusium griseum and the superficial layer of the corpus callosum. They were not identified within the callosal sulcus. These arteries also supplied the fornix and the septum pellucidum.

Cingulocallosal Arteries

These vessels were present in 100% of the hemispheres. The average number was 9 (2–21) for each hemisphere and the mean diameter at their origin was 0.27 mm (range: 0.17–0.61 mm) (Figs. 1 and 2). These arose from the lateral and inferolateral aspect of the pericallosal artery in all hemispheres studied and ran laterally to enter the callosal sulcus where they supplied the corpus callosum. These were the dominant arteries in the blood supply of the corpus callosum. The cingulocallosal arteries gave rise to three types of arteries: (1) the callosal arteries, which immediately passed inferiorly and penetrated the corpus callosum after a short course to supply it; (2) the cingulate artery, which immediately ran superiorly from its origin to supply the cingulate gyrus; and (3) the sulcal arteries, which coursed laterally to reach the callosal sulcus and supply the corpus callosum. The branches of the cingulocallosal arteries anastomosed with each other.

Recurrent Cingulocallosal Arteries

The recurrent cingulocallosal arteries were thin branches and were present in 28.3% of the hemispheres. The average number of these vessels was 1.4 (0–3) in each hemisphere and the mean diameter at their origin was 0.32 mm (range: 0.21 to 0.49 mm) (Fig. 3). These vessels arose from one of the cortical branches of the distal anterior cerebral artery, especially from the superior internal parietal artery. After originating from the cortical arteries, they ran posteroinferiorly to reach the medial surface of the cingulate gyrus where they entered the callosal sulcus to supply the cingulate gyrus and the corpus callosum and also contribute to the pericallosal pial plexus.

Long Callosal Arteries

Most of these arteries terminated at the medial longitudinal stria and were present in 46.6% of hemi-

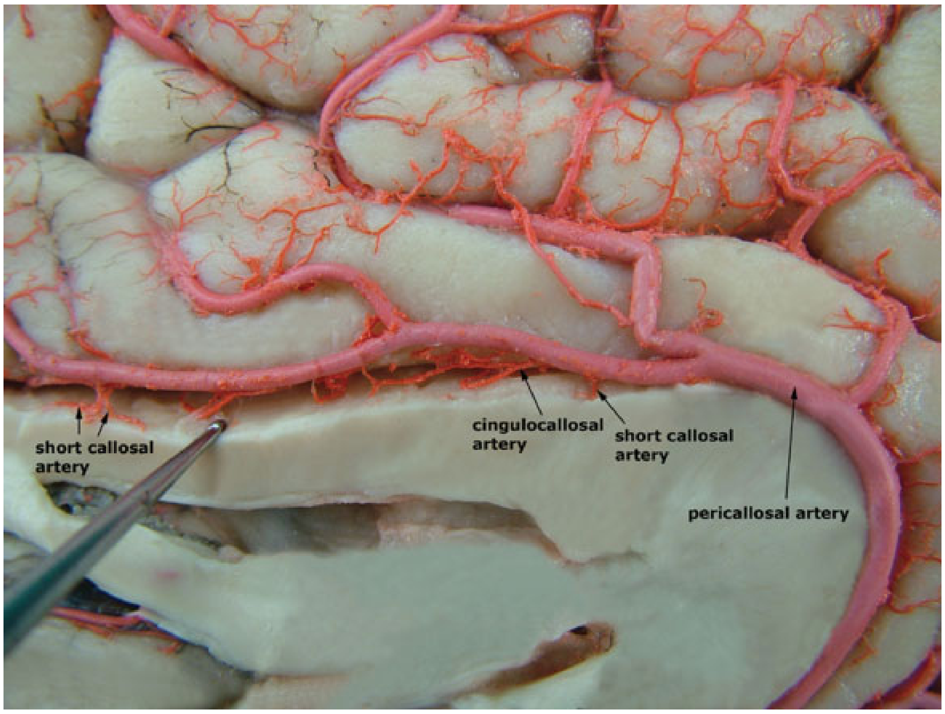

Fig. 1. Short callosal artery originating from the pericallosal artery. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

spheres with an average number of 0.8 (0–2) for each hemisphere; the mean diameter at their origin was 0.54 mm (range: 0.37–1.06 mm) (Fig. 4). These vessels originated from the inferolateral surface of the pericallosal artery in all hemispheres, coursed parallel to the pericallosal artery within the callosal sulcus, reached the corpus callosum, and ended after giving multiple perforating branches to the corpus callosum in the midline, especially to the body of the corpus callosum. They also gave rise to multiple branches that contributed to the pericallosal pial plexus. These vessels supplied the corpus callosum, adjacent cortex, septum pellucidum, septal nuclei, and column of the fornix. The long callosal arteries were similar to the short callosal arteries in regard to their origin and distribution, but had longer courses.

Median Callosal Arteries

These vessels were present in 33.3% of the brains; their mean diameter at their origin was 1.28 mm (range: 0.50–1.97 mm). These vessels usually originated from the ACoA as a single trunk. After their origin, these vessels were observed to run anterosuperiorly to the rostrum, curve around the genu of the corpus callosum, and end in the cingulate gyrus at the level of the body of the corpus callosum. During their course, they gave rise to perforating branches to the rostrum, genu and body of the corpus callosum, and to the cingulate gyrus. We found one atypical median callosal artery that originated from the junction of the A1 and A2 segments

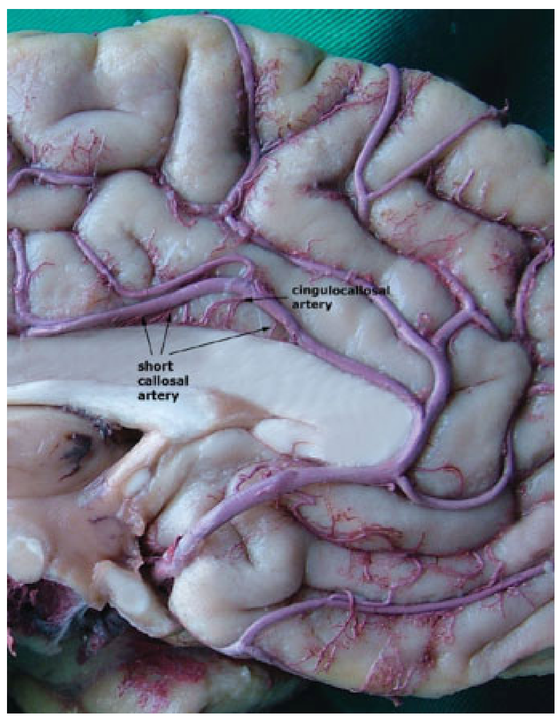

Fig. 2. Cingulocallosal arteries originating from the pericallosal artery. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

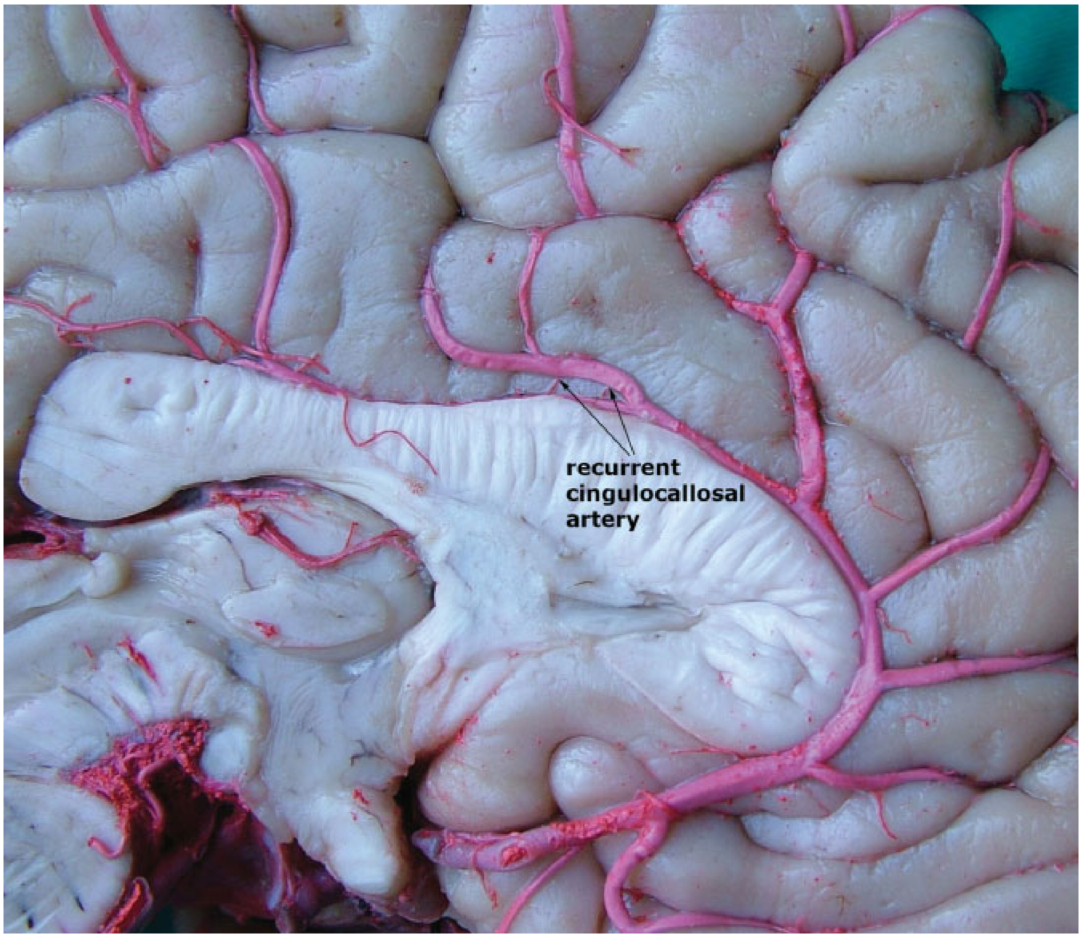

Fig. 3. Recurrent cingulocallosal artery seen originating from the cortical branch of a pericallosal artery. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

of the anterior cerebral artery (Fig. 5). After its origin, it followed the same course, as that of a normal median callosal artery, extended as posteriorly as the splenium, and anastomosed with branches of the posterior part of the pericallosal artery. This atypical median callosal artery covered an atypical territory. During its course, a new arterial variation arising from the anterior surface of the atypical median callosal artery was also observed, which we described as an atypical subcallosal artery. It ran anterosuperiorly to the rostrum, curved around the genu, and ended at the junction of the genu and body of the corpus callosum.

DISCUSSION

The anatomy of the corpus callosum is important to clinicians (e.g., radiologists, neurologists) and neurosurgeons during such procedures as interhemispheric approaches to intraventricular lesions, anterior cerebral artery aneurysms, and epilepsy surgery (e.g., callosotomy) (Yaşargil, 1984; Malobabic et al., 1989; Goncalves-Ferreira et al., 2001). The corpus callosum is functionally well-defined. Its arterial supply, however, has not been comprehensively described, except for scant anatomical studies (Perlmutter and Rhoton, 1978; Ture et al., 1996; Kakou et al., 2000) (Table 2). The callosal arteries have been classified differently by various authors. There is no classic and/or standard definition for the callosal branches of the pericallosal artery. We based our classification on that used by (Ture et al., 1996). We found that the pericallosal artery coursed at a variable distance superior to the corpus callosum in some hemispheres. The short callosal arteries and the cingulocallosal arteries were found to be the major arterial supply for the corpus callosum. These arteries arose from the inferolateral surface of the pericallosal artery. Therefore, they might not be seen during surgical procedures that retract the cingulate gyrus (e.g., interhemispheric approach to the third ventricle). Although we found that all callosal arteries contributed to the pial plexus, the long callosal arteries were the primary contributors to this network. The recurrent cingulocallosal artery is a very thin branch that arose from large cortical branches of the pericallosal artery and would be sus-

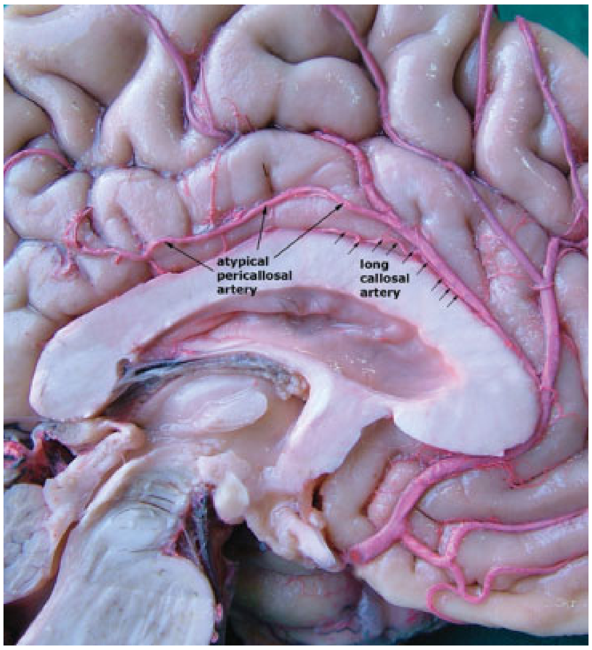

Fig. 4. Long callosal artery seen originating from the pericallosal artery and atypical course of the pericallosal artery. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

ceptible to surgical retraction. If one or both pericallosal arteries are not present or atrophic, their corresponding territory may be vascularized by a hypertrophied median callosal artery. In our study, the median callosal artery was present in 33.3% of brains when compared with 4, 30, and 35% in the studies of Perlmutter and Rhoton (1978), Ture et al. (1996), and Kakou et al. (2000), respectively. This vessel has been described as a third pericallosal artery. According to Ture et al. (1996), the median callosal artery and the subcallosal artery are different arteries because of their different distal distributions. In this study, both arteries originated from the same site (ACoA), followed the same course, and supplied similar structures. One single difference between these branches was their distal distribution, terminating at the body and genu of the corpus callosum, respectively. Because there was no significant difference between them, we believed it appropriate to refer to these as ''median callosal arteries.'' Although the median callosal artery has been reported to arise from the ACoA, we found an atypical median callosal artery originating from the junction of the A1 and A2 segments of the anterior cerebral artery. A fetal azygos pericallosal artery with a median callosal artery branch has been found to supply the left cingulate gyrus, paracentral lobule, and precuneus by Vasovic (2006). The atypical subcallosal artery originating

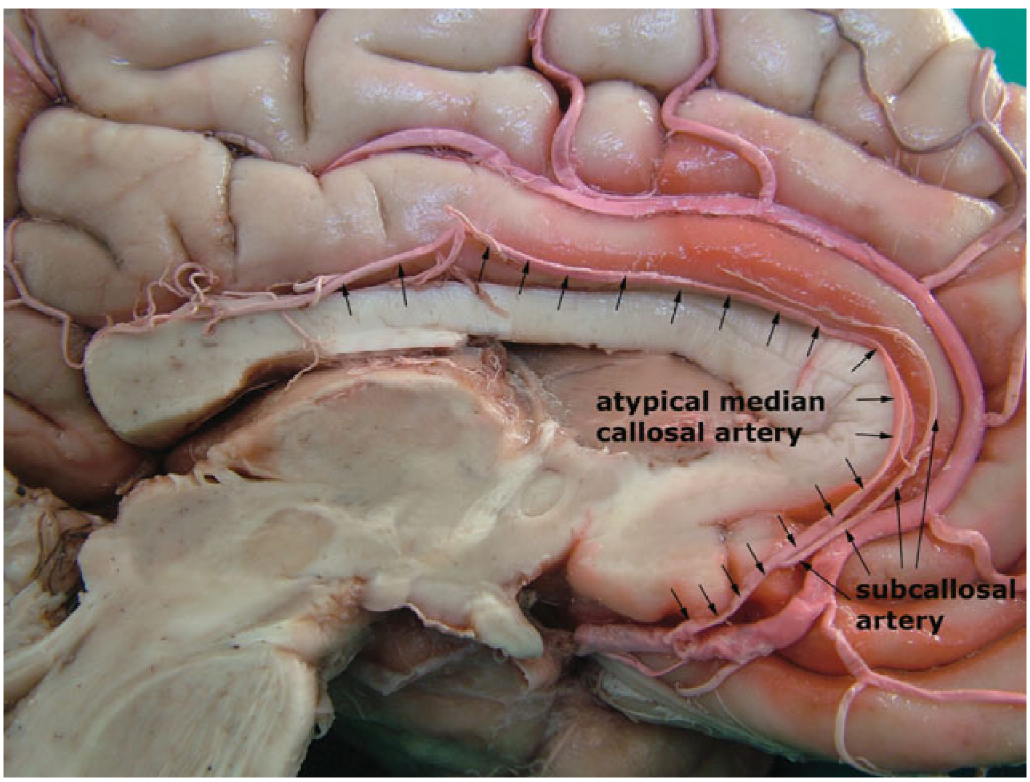

Fig. 5. Atypical median callosal artery seen originating from the junction of the A1 and A2 segments of the anterior cerebral artery. In this case, an atypical subcallosal artery is a branch of this artery. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

TABLE 2. Presence of Arteries Supplying the Corpus Callosum from Different Studies

	Perlmutter and Rhoton	Gomes et al.	Ture and Yaşargil	Kakou et al.	This study
Short callosal artery	98%	100%	50%		96.6%
Long callosal artery	''In a few cases''		55%		46.6%
Cingulocallosal artery		100%	100%	100%	100%
Recurrent cingulocallosal artery			45%		28.3%
Median callosal artery		10%	30%	35%	33.3%
Subcallosal artery			50%		

from the atypical median callosal artery, as seen in our study, has not been previously reported. Each of these arteries gave rise to perforators of the corpus callosum. Our study found that the callosal arteries gave rise to perforating branches to the indusium griseum and all portions of the fornix. We found that the vascularization pattern for the corpus callosum encountered in each hemisphere is somewhat different. To carry out confident surgical interventions, anatomical variations and ''normal'' anatomy should be heeded. Such data would be especially useful when performing such procedures as endoscopic corpus callosotomy (Tubbs et al., 2004).

Corpus callosotomy is a useful therapeutic procedure for the management of some types of medically refractory epilepsy. Traditional methods of callosotomy must be performed carefully to avoid excessive retraction of the cerebral hemispheres with potential injury to the branches of the anterior cerebral artery. Awareness of both the normal and variable anatomy of such vessels may be of use during surgical intervention and may prevent unwanted iatrogenic complications (Tubbs et al., 2006). Callosal injury can result in various neurological disorders, which are collectively named the disconnection syndromes and include the clinical findings of personality, consciousness and behavior impairment, mutism, and apraxia (Devinsky and Laff, 2003; Clarke et al., 2007). Coagulation or injury of the callosal arteries may result in memory loss.

Knowledge of the arterial branches reported in this study may reduce surgical morbidity following operative approaches near or through the corpus callosum. Also, one might theorize that with the advent of new technologies, selective intravascular ablation of callosal branches could potentially replace or augment open intracranial transection of the corpus callosum by devascularizing it.

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