THE POSTERIOR THALAMOPERFORATING ARTERY
(THE MAIN PERFORATING TRUNK FROM P1)
MICROSURGICAL STUDY

Aziz Rassi Neto, MD, Apo Claudio Marilhas Antunes, MD, PhD and Fernando Menezes Braga, MD, PhD

ABSTRACT — Thirty fresh human brains were studied regarding to the anatomy of the posterior thalamoperforating arteries (PTHAs): origin, number, diameter, trajectory, distance from the basilar artery bifurcation, type of distribution and correspondent area of vascularization. Most of the PTHAs originated proximally in the posterior cerebral artery (PCA), irrigating the cerebral peduncles, mammillary bodies, ventral portion of midbrain and, through the posterior perforated substance, the medial portion of thalamus. The mean number of PTHAs per hemisphere was 1.51; mean proximal diameter 0.60 mm and mean distance from PCA origin 2.47 mm. A deep knowledge of the microsurgical anatomy of PTHAs is stressed, as devastating lesions can develop after arterial compromise during neurosurgical procedures.

Key words — Microsurgical anatomy, posterior cerebral artery, posterior thalamoperforating arteries.

RESUMO
ARTÉRIA TALAMOPERFURANTE POSTERIOR — ESTUDO MICROCRÍRURGICO

Foi realizada preparação de 30 encéfalos humanos frescos, com o objetivo de estudar as artérias talamoperforantes posteriores (ATPP), no que se refere à origem, número, diâmetro, trajeto, distância da origem da artéria cerebral posterior (ACP), distribuição e áreas de irrigação. A maioria das ATPP se origina proximalmente na ACP, irrigando os pedúnculos cerebrais, corpos mamílares, porção ventral do mesencéfalo e porções médias do talâmico. O número médio de ATPP por hemisfério foi 1,51; o diâmetro proximal médio, 0,60mm e a distância da origem da ACP, 2,47mm. O conhecimento aprofundado da anatomia microcirúrgica da ATPP é enfatizado, com base na gravidade das lesões neurológicas que se produzem com seu comprometimento durante procedimentos cirúrgicos.

Palavras-chave — Anatomia microcirúrgica, artéria cerebral posterior, artéria talamoperfurante posterior.

INTRODUCTION

Since the work of Langworth & Fox (1937), many authors studied the thalamoperforating arteries (TPA), but we have seen few papers with anatomical details. Zeal & Rhoton (1962) studied fifty formalin-fixed cerebral hemispheres, their origin and diameter. Marinovic et al. (1982) examined 69 posterior cerebral arteries (PCA) from 36 human brains, 28 of them injected with a mixture of 10% India ink, fixed in formaldehyde solution. They studied the origin of TPA, its diameter, its distance from the basilar artery bifurcation and zone of penetration.

The posterior thalamoperforating artery (PTHPA) supplies the cerebral peduncles, the mammillary bodies, the oculomotor nerve, the medial ventral portion of midbrain and penetrates into the posterior perforated substance to supply the subthalamic region and the medial portion of the thalamus (1,3,4,5).

MATERIAL AND METHODS

Thirty fresh human brains (15 males and 15 females) were studied after injection of Neoprene Latex (Du Pont, USA) with red coloured water.

Two different methods were used to inject the cerebral vascular system, described as methods 1 and 2.

In method 1, the injection was done in the common carotid artery, in the ventrolateral face of the neck and, twenty-four hours later, the brain was removed from the skull.

In method 2, the encephalon was first removed from the skull and the injection was done in the basilar artery.
THE POSTERIOR THALAMOPERFORATING ARTERY (THE MAIN PERFORATING TRUNK FROM PCA) - MICROSCORICAL STUDY

Fig. 1 — Interpeduncular cistern (partially opened) (1), before removing the brain from the skull; superior portion of the basilar artery (2); proximal portion (π1) of PCA (3); superior cerebellar artery (4), partially inside the interpeduncular cistern; optic nerve (5); carotid artery (6); oculomotor nerve (7); the second portion (π2) of PCA (8); PCA (9) and tentorium (10).

Fig. 2 — Interpeduncular cistern (antero-inferior view) — the posterior face of infundibulum (1); latero-superiorly, the oculomotor nerve (2); latero-inferiorly, the ambient cistern (3); posteriorly, the superior third part of the basilar artery (4); PCA (5); the superior cerebellar artery (6); double in this case, the posterior communicating artery (8); the long circumflex artery (9) and mammillary bodies (10).

Fig. 3 — Schematic representation of the diencephalon and PTHPa. Frontal section at the level of the mammillary bodies.

In both cases the encephalons were fixed in 10% formalin solution.

RESULTS

The PTHPAs in most of our cases originated in the proximal portion of the PCA, soon after dividing into three arterial groups; peduncular (ventrolateral branches) that penetrate into the ventral portion of the cerebral peduncle; mesencephalic (medial branches) that penetrate into the inferior portion of the posterior perforated substance and running to the medioventral portion of the midbrain; diencephalic (ventrolateral branches) that penetrate into the superior portion of the posterior perforated substance running to the medial portion of the thalamus (figs. 1, 2, 3).

Number of PTHPAs

After exposing the arachnoid membranes of interpeduncular cistern, and dissecting PTHPAs, their number ranged from 0 to 4 per hemicephalon: we found 4 arte-
ries in the same hemiencephalon in only one case; 3 arteries in eight cases and, in two cases, we didn’t find the homolateral PThPA; cerebral irrigation compensated by the opposite vessels.

The average number of these arteries per hemiencephalon was 1.51 arteries, ranging from 1.66 arteries in males and 1.36 in females.

Origin
The PThPA originated from the P1 segment of PCA in 98.9% of the cases. In only one case the PThPA came from the medial posterior choroidal artery (fig. 6).

Distance between the basilar artery bifurcation and PThPA origin
The mean distance was 2.47mm (2.54mm — males; 2.41mm — females).

Diameter
The diameter was measured in the proximal part of the PThPA and in its distal part, at the point of penetration in the posterior perforated substance. In its proximal segment, the mean diameter was 0.60mm and, in its distal segment, 0.20mm, mean values of 0.43mm (males — 0.46mm; females — 0.47mm).

Traject
The traject was studied from the origin of the PThPA up to the posterior perforated substance. It was divided into three groups referring to the more or less tortuosity of PThPA (fig. 7).

Sinuous, when the artery runs doing a short curve (fig. 5). S shaped, when the artery has a convexity
curve followed by a concavity curve. Rectilinear, when the artery has a straight direction (fig. 8). As above, we found in 91 studied arteries the following distribution: sinusous trajet: 37 arteries (40.65%); S shaped trajet: 35 arteries (38.46%); rectilinear trajet: 19 arteries (20.87%).

**Site of penetration**

The cerebral peduncle receives branches of the PThPAs in 93.33% of cases, the mammillary bodies in 60%; the oculomotor nerve in 48.33%; the midventral portion of the midbrain in 98.33%; the subthalamic region and the thalamus in 100% of the 60 hemispheres studied.

**Type of presentation**

The type of presentation was defined by the number of arteries and the side of penetration in the encephalon, method modified from the report of Langle & Brunner(8) (fig. 9).

Type I, when the PThPAs originate from each hemispheric and the penetration occurs in each side of the brain.

Type II, when the PThPAs originate from one hemisphere and the penetration occurs in both sides of the brain.

Type III, when two PThPAs originate from one or both hemispheres and the penetration occurs in each side of the brain.

Type IV, when three or four originate from one or both hemispheres and the penetration occurs in each side of the brain (fig. 4).

Fig. 9 — Schema of presentation types (PThPA).

Type I PThPA was present in 46.66% of the 30 cases of hemispheres studied; type II, in 6.66%; type III and IV were present in the same proportion, 23.33% of the cases.

**DISCUSSION**

The study of cerebral perforating vessels is very important for the neurosurgeon because peri-operative damage can cause cerebral ischemia and bad evolution of the patients operated on.

The more frequent distribution of these arteries we found was one artery in each hemispheric (46.66% of the cases). Sack & Rhoton(10) reported that an average of 4 perforating branches (range 1 to 13) originated from the PCA, although only one or two arteries go through the posterior perforated substance (PThPAs).
Zeai & Rhoton(19) found an average of 2.7 PThPAs per hemisencephalon; Marinkovic et al(9) found 2.0 arteries per hemisencephalon, but noticed in 2 cases (of the 69 studied) 4 arteries or more per hemisencephalon. In our series we found in only one case 4 PThPAs per hemisencephalon: the mean number of PThPA per hemisencephalon was 1.51 arteries, similar to the reported series(9,13).

Hara & Fujino(4) found the PThPAs originating directly from the basilar artery, however we didn’t find this occurrence in our cases.

Marinkovic et al(9) reported the PThPA originating from P1 in 47.8% of cases and from the medial posterior choroidal artery in 4.3%. In our cases we found the origin in the medial posterior choroidal artery in only one case; in all other cases (98.9%) the origin was P1, as reported by others(3,19).

The distance between the basilar artery bifurcation and the PThPA origin was reported by few authors: Saeki & Rhoton(13) found 2.2 mm (average) and Marinkovic et al(9) 2.1 mm (average); in our cases the mean distance was 2.47 mm.

The mean diameter of the PThPAs ranges from 0.39 mm to 0.7 mm(9,13,19), and in our series was 0.43 mm. The most frequent trajectory reported by Marinkovic et al(9) were the sinuous and the S shaped, the rectilinear trajectory was less frequent one (20.8%).

As reported by some authors(3,7,8,13) the PThPA and its branches supply the cerebral peduncle, mammillary body, oculomotor nerve, midbrain (ventromedial portion) and penetrate into the posterior perforated substance to supply the subthalamic region and the thalamus. The distal part of this artery also supplies the posterior portion of the internal capsule(9).

Marinkovic et al(9) reported that the oculomotor nerve receives branches of the PThPA, or branches coming directly from PCA in 14.5% of the cases. In our series we noticed that the oculomotor nerve receives branches from the PThPA in 48.33%. Referring to the mammillary bodies, Marinkovic et al(9) found branches from PThPA in 26% of cases, much less than we found (60%).

The PThPA gives off branches to the cerebral peduncle, midbrain, subthalamic region and thalamus in more than 90% of the cases.

Regarding to the type of presentation, we observed that the prevalence of type 1 was 46.66%, corresponding to the type III described by Lang & Brunner(19) (42%). Prevalence of our type II presentation and the corresponding type IV of Lang & Brunner(19) was almost similar, respectively 6.66%. Type III and type IV (corresponding to the type I of Lang & Brunner(19) were found in 46.66% of our cases, but in 20% of their series.

In conclusion, the risks of surgery in the interpeduncular cistern can be reduced by the deep knowledge of the microanatomy of the region, especially regarding the thalamoperforating arteries, as their damage can produce devastating lesions.

REFERENCES
