

Descriptive Analysis of the Arterial Supply to the Auricle in Patients with Unilateral Microtia

Erik Agustín
Márquez-Gutiérrez, MD*
Claudia Gutiérrez-Gómez del
Hierro, MD†
Jorge Humberto Rodríguez-Quintero, MD*
Jorge Enrique Pereyra-Arzate, MD*
Rodolfo Rivera-Martínez, MD‡

Background: Microtia is a congenital auricular deformity that occurs in 1:5,000–10,000 births. It can cause severe impairment to the patient's self-esteem and problems regarding social integration. Multiple measures have been described in attempt to better operative outcomes of these patients. We used computed tomography (CT) angiography to analyze the vascular pattern of the auricular region before surgery.

Methods: Fourteen patients with unilateral microtia were included. All underwent CT angiogram plus tridimensional reconstruction. Both healthy and microtic auricles were analyzed descriptively in terms of main arterial supply, pattern, diameter of subbranches, and angulation. The sample was divided in 2 age groups for better understanding of the data.

Results: Blood supply to the auricle was found to depend on 2 main vessels: temporal superficial artery (TSA) and its subbranches (superior, middle, and lower branch) and posterior auricular (PA) artery. In the microtic group, TSA was the dominant artery in 13 of 14 cases (92%). Superior, middle, and inferior branches were present in 4, 3, and 0 cases, respectively. Three of the microtic auricles presented supply from PA artery, from which in 1 case, it represented the only supply to the region.

Conclusions: There is wide variability in the blood supply of both healthy and microtic auricles; however, we were able to identify some tendencies in our sample. Further research is needed to prove the benefit of a preoperative imaging study in these patients. Still, in our experience, we found it useful as a complement for surgical planning. (*Plast Reconstr Surg Glob Open* 2017;6:e1594; doi: 10.1097/GOX.0000000000001594; Published online 28 December 2017.)

INTRODUCTION

Microtia is a congenital external ear deformity that occurs in about 1 of every 5,000–10,000 births.^{1,2} It occurs as a broad range of malformations involving to variable degrees the structures derived from the first and second brachial arches. Failure in the development of specific events occurring during the sixth through eighth weeks of gestation is believed to lead to the clinical spectrum of microtia.³

The unilateral form occurs in 79–93% of the cases,^{4,5} in which the right side is affected in 57.1%.^{6,7} It is more frequent in males, with a 20–40% increased risk compared with females,⁷ and it has been associated with several syndromes such as Treacher Collins, Nager, Fraser, and epidermolysis bullosa,⁷ and also has been described in patients with the oculo-auriculo-vertebral phenotype and in association with cervical spine fusion and renal malformations.⁶ Risk factors such as low birth weight, higher maternal parity, maternal acute illness, medication use during pregnancy, and maternal diabetes mellitus have been described on the literature.^{6,8}

Several classification schemes have been used for auricular defects.^{9,10} In this study, we used the Tanzer classification and focused on cases presenting with complete hypoplasia with or without atresia of the external auditory canal (Tanzer classification IIA/IIB).¹⁰

Microtia can cause severe impairment to the patient's self-esteem and social integration.^{11,12} Several studies have

From *Plastic Surgery Department, Instituto Nacional de Rehabilitación INR, Mexico City, Mexico; †Plastic Surgery Department, Hospital General Manuel Gea González, Mexico City, Mexico; and ‡Radiology Department, Hospital General Manuel Gea Gonzalez, Mexico City, Mexico.

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documented the benefits from early surgical reconstruction^{13,14} and the problems related to a delayed approach.¹⁵

Regarding the reconstructive method, several techniques have been described; being one of the most frequently used is the 2-stage procedure described by Nagata,¹⁶ which consists of primary grafting, fabrication, and insertion of a tridimensional cartilage framework from the sixth to ninth ribs, which is later elevated and positioned during a second surgical stage. Exposure of the cartilage framework is the most feared complication in auricular reconstruction and is commonly associated with necrosis of a poorly vascularized skin pocket.²

The vascular supply to the auricle comes from either 1 of 2 separate but (sometimes) intercommunicating arterial networks derived from the external carotid system (anterior and posterior). The anterior network is derived from branches of the superficial temporal artery (STA), which are a superior branch (SB), a middle branch (MB), or an inferior branch (IB), whereas the posterior network is derived out of perforators from the posterior auricular (PA) artery. In some cases, both these networks tend to interconnect throughout the triangular fossa and over the helical rim, allowing for either one to supply the auricle. Venous drainage flows through the PA veins into the external jugular, the superficial temporal, and the retro mandibular veins.³

Multiple measures have been used to decrease complication rates of the operative procedure.^{17,18} Initially, Nagata¹⁶ described a security pedicle when performing the primary incision and dissecting the flap, in an attempt to avoid compromising the blood supply of the area; however, later on, Firmin¹⁹ demonstrated that even with the use of the security pedicle necrosis of the superior pole was still a possibility, this being probably because of the anatomical variability in the arterial blood supply to the auricle between patients. More recent techniques have integrated the use of tissue expansion before cartilage framework insertion showing a decrease in complication rates.²⁰

The use of several imaging modalities has been described in the approach of patients with microtia, the most common being Doppler ultrasound.^{21–24} Computed tomography (CT) has also been used as an adjuvant in planning the reconstructive procedure. In most cases, its use has been limited to evaluate the anatomy of the thoracic wall, estimating the costal cartilage volume available,^{25,26} and to evaluate the affected ear remnant, inspecting for the presence of atresia, stenosis, and other anomalies of the auditory canal.²⁷

The objective of this study is to introduce the use of CT angiography (CTA) to get a detailed description of the vascular supply of the auricle in patients with microtia. We believe that this approach could improve outcomes by allowing the surgeon to make an individualized approach on each particular case.

MATERIALS AND METHODS

All microtia patients admitted to the Plastic Surgery Department of Hospital General Manuel Gea González, in the period from April to November 2008, were considered

for the study. Our research protocol was approved by the Ethics Committee of Hospital General Dr. Manuel Gea Gonzalez and was conducted in accordance to the declaration of Helsinki (1964). All the patients signed an informed consent before the start of the study. All patients assessed by the department in the aforementioned period had unilateral complete hypoplasia with or without atresia of the auditory canal (Tanzer IIA/IIB). The skin over the mastoid area was healthy in all patients. Patients with acquired disease (those who sustained accidental/traumatic ear tissue loss) or those referred to our service with a previous reconstructive procedure were excluded from the study. A total of 14 patients were included in the study for the analysis of 28 auricles.

CTA images were obtained using a Siemens Somatom Sensation (64 detectors) device (95% sensitivity and 97% specificity to detect arterial vessels²⁸). A total of 80 ml of non-ionic iodated contrast media (Iomeron 350 mg/ml) were administered via cephalic vein at 4–5 mL/second/sec, and the scan was started after 15 seconds. Then, 0.6-mm slices were obtained in the axial plane from the clavicle to the cranial convexity. Our patients were exposed to a standard dose of radiation according to the protocol (effective dose: 2–4 mSv). All patients were exposed to the least amount of radiation possible. Tridimensional reconstruction with bone subtraction was performed with the addition of mediastinal filter to all images. The image data were stored in the standard DICOM format. Measurements were made on the 3D reconstructed image to assess (1) the presence of the individual branches of temporal superficial artery (TSA) and PA, (2) the diameters of the main vessels and branches of the STA, (3) the angle of emergence of the branches, considering as baseline the intersection of the TSA with the zygomatic arch.

The collected data were tabulated and analyzed using IBM SPSS Statistics Version 21 (64 bit) for Windows (Copyright 1989–2012 IBM Corporation and others). Analysis was made regarding the age, percentile presence of specific branches and subbranches in each group, and angulation. For the analysis of the diameters, the sample was divided in 2 age groups, 3–9 years and >9 years for better understanding of the data obtained. Mean, minimal, and maximal values were computed for the diameters. Then, a descriptive comparison was made between healthy and microtic auricles and between age groups (Figs. 1A, B, 2A, B, 3A, B).

RESULTS

Regarding the baseline characteristics of the group, the mean age of the group was 9 years (range: 3–27), the male-to-female ratio was 1.3:1, with 8 males (57%) and 6 females (43%). All our study samples were Mexican patients, and there was a slight right-sided preponderance of microtia, with 8 of 14 (57%) of microtic auricles being on the right side.

As for the dominant arterial supply, we found that STA was the dominant vessel in 13 of 14 healthy auricles (92%) and in 11 of 14 microtic auricles (78%). In the remaining cases, dominant supply was given by the PA artery. In both groups, 14% of patients presented both major arteries;

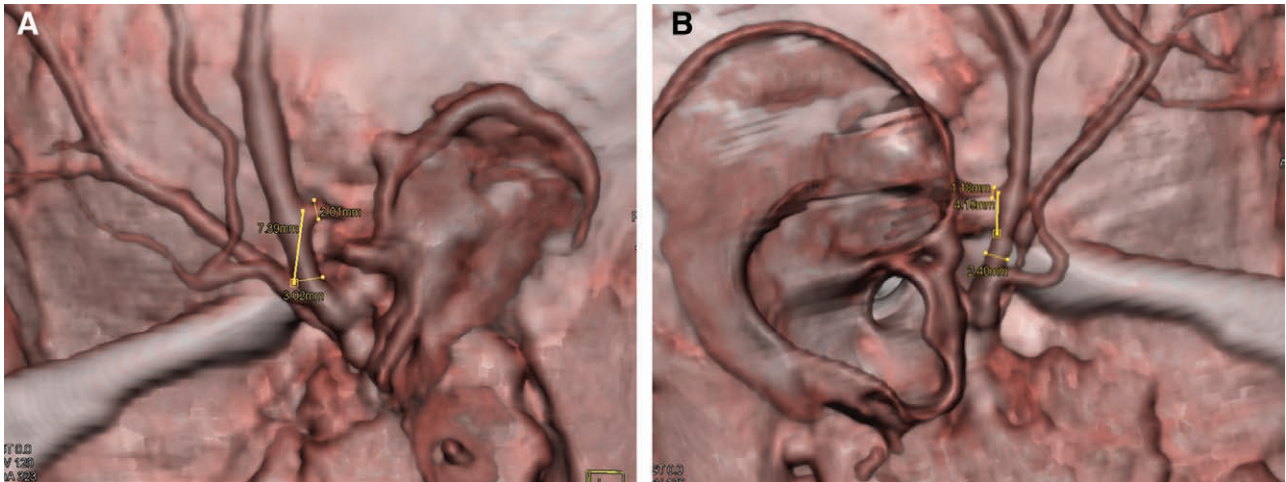


Fig. 1. A, Case 5, 8-year-old girl. Microtic left auricle with dominant SB (2.01 mm). Auricle supplied only by SB of TSA. B, Case 5. Healthy right auricle with dominant MB (1.18 mm).

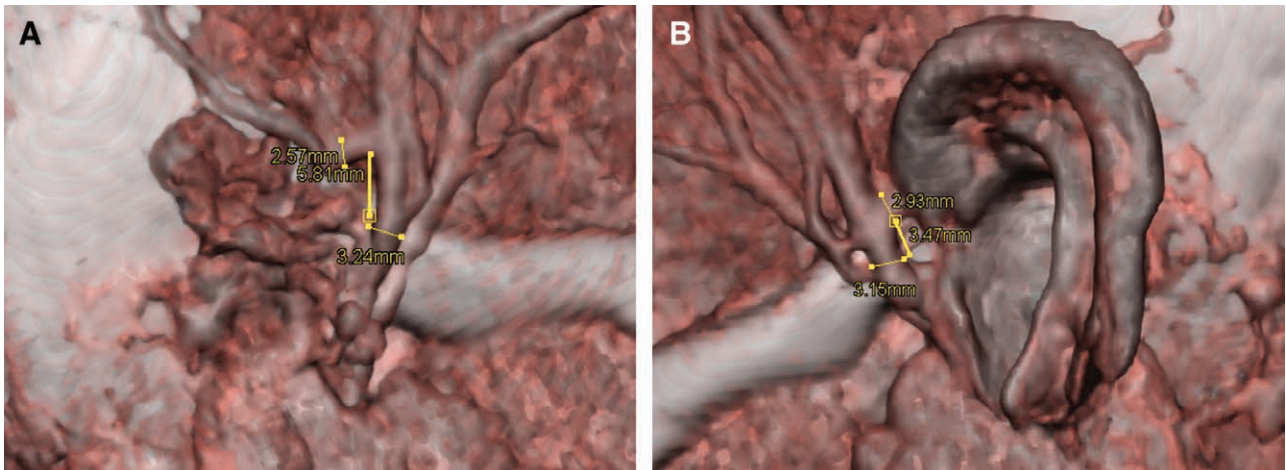


Fig. 2. A, Case 7, 10-year-old boy. Microtic right auricle with dominant SB (2.57 mm). Auricle supplied only by SB of TSA. B, Case 7. Healthy left auricle with dominant SB (2.93 mm).

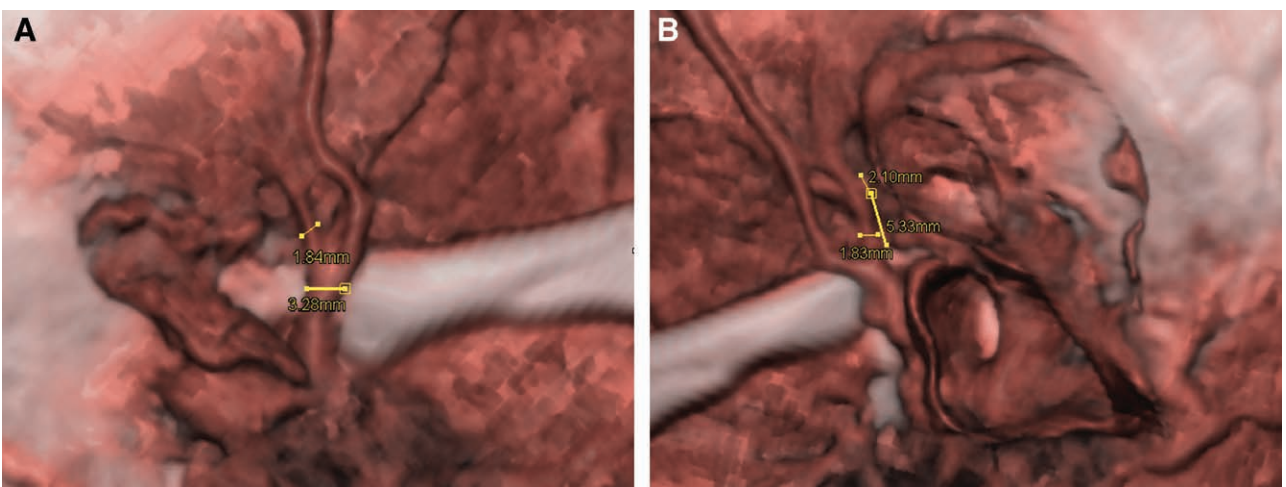


Fig. 3. A, Case 9, 5-year-old boy. Microtic right auricle, with dominant SB (1.84 mm). Auricle supplied only by SB of TSA. B, Case 9. Healthy left auricle with dominant SB (2.10 mm).

however, dominance was defined by considering the vessel with the major width. The SB of TSA was present in 4 microtic and 9 healthy auricles. The MB was present in 3 microtic and 5 healthy auricles and the IB was present in no microtic auricles and in 3 healthy auricles.

With respect to the diameters, in the 3–9 year group, TSA had a mean diameter of 2.75 mm in healthy compared with 2.64 mm in microtic auricles; SB: 2.07 mm in healthy compared with 1.82 mm in microtic auricles; MB: 1.35 mm in healthy compared with 1.72 mm in microtic auricles; IB: 1.67 mm in healthy auricles with no IBs found in microtic auricles; and PA: 2.05 mm in healthy

and 2.84 mm in microtic auricles. In the >9-year group, TSA: 2.59 mm in healthy versus 3.25 mm in microtic; SB: 2.68 mm in healthy versus 2.57 mm in microtic; MB: 1.18 mm in healthy versus 2.9 mm in microtic; IB: 0.9 mm in healthy with no IB on microtic auricles; and lastly PA: 3.15 in healthy versus no PA in microtic auricles. The mean diameters of whole groups (without age division) are summarized in Tables 1 and 2.

About the emerging pattern in the microtia group, 100% of the SB and IB arose from the STA, whereas only 87% of the MB arose from STA, the remaining 13% being branches of the SB itself. SB of STA was present in

Table 1. Microtic Auricle Group: Arteries and Branches

		Temporal Superficialis	SB	IB	Middle or MB Branch	PA
N= 14	Present	13	4	0	3	3
	Absent	1	10	14	11	11
Mean (mm)		2.8300	2.0075	—	2.1167	2.8400
Minimum		1.84	1.61	—	1.61	2.27
Maximum		4.37	2.57	—	2.90	3.22

Summary of mean diameters of the microtic group.

Table 2. Healthy Auricle Group: Arteries and Branches

		Temporal Superficialis	SB	IB	Middle or MB Branch	PA
N= 14	Present	14	9	3	5	2
	Absent	0	5	11	9	12
Mean (mm)		2.7043	2.2733	1.4133	1.3040	2.6000
Minimum		1.83	1.10	0.90	1.13	2.05
Maximum		3.64	3.32	2.18	1.61	3.15

Summary of mean diameters of the healthy group.

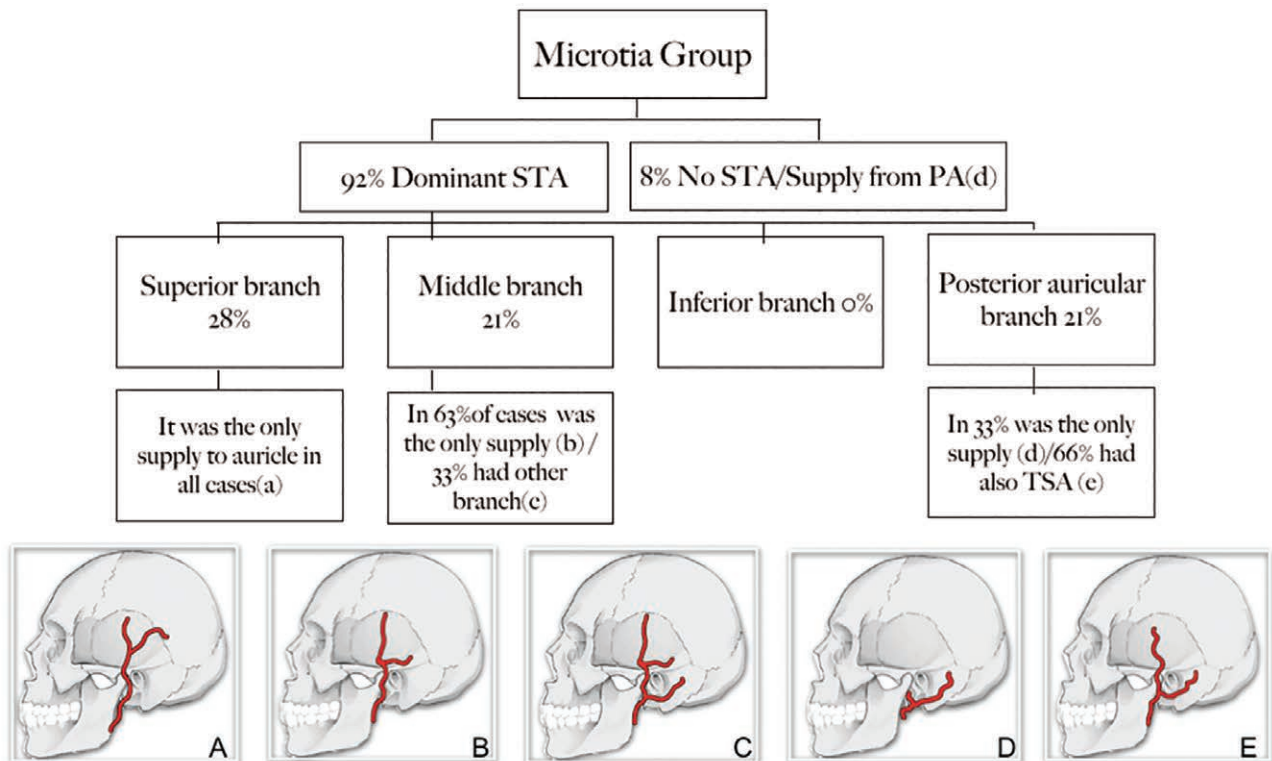


Fig. 4. This diagram outlines how the different variants of the vasculature coexist in our study group.

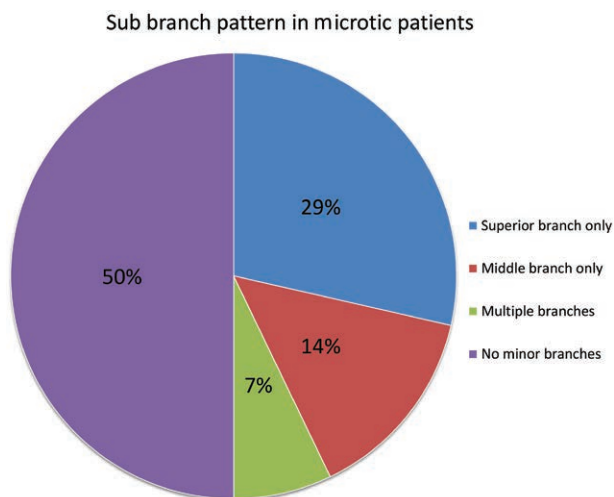


Fig. 5. Minor branch pattern in microtic group.

28% of the cases, and in all of those cases, it represented 100% of the blood supply to the auricle, meaning no other branches of STA or PA were present. MB was present in 21% of the cases, of which 33% had an additional branch supplying the auricle. PA was present in 21% of the cases, of which 66.6% had an additional branch supplying the auricle. These findings were summarized in Figure 4. Branch patterns in the microtic group were summarized in Figure 5. The healthy auricle group showed an emerging pattern with SB in 64% of the cases; in 77% of such cases, it represented 100% of the blood supply to the auricle. MB was present in 35% of cases; in 40% of such cases, it was the only supply to the auricle. IB was present in 21% of cases, with an additional subbranch in all cases. PA was present in 14%, all of which had additional supply from TSA. Lastly, analyzing the whole sample, the SB had a mean angulation of 55 degrees, MB of 58 degrees, and IB of -63 degrees (Figs. 4, 5).

DISCUSSION

This study aimed to offer a broad description of the vascular patterns of a group of patients with microtia using CTA. We were able to obtain high-quality images precisely defining the anatomy of the auricular region, which were helpful in tailoring an individualized operative plan, allowing the surgeon to modify the design of the initial incision and flap depending on vascular dominance. CTA is nowadays a readily available imaging method in most third-level centers, and advances in both the devices and protocols permit reduction of radiation exposure and absorbed radiation to the lowest possible. However, this method still entails exposing young patients to a considerable amount of radiation, so an alternative imaging study should be considered in selected patients. The use of Doppler ultrasound has been described for similar purposes and has shown good results²²; nevertheless, it has the disadvantage of not offering a tridimensional reconstruction of the anatomy and being an operator-dependent method. During data analysis, we identified wide variability in

vascular patterns within both groups, but we could indeed observe some tendencies, which may be helpful in operative planning. We are aware that further research on the topic is needed to make precise recommendations for surgery based on vascular patterns; however, considering the consequences of a negative reconstructive outcome in these patients, it may be of benefit to consider the study at least on a case to case basis.

Jorge H. Rodríguez-Quintero, MD

Instituto Nacional de Rehabilitación (INR)

Calzada México-Xochimilco 28

Arenal de Guadalupe

Tlalpan, Ciudad de México

México 14389

E-mail: huroqu90@gmail.com

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