The middle meningeal artery as an alternative route for intra-arterial chemotherapy

Mario Zanaty a, Nohra Chalouhi a, Carol L. Shields b, Stavropoula Tjoumakaris a, Robert H. Rosenwasser a, Pascal Jabbour a, b,⁎

a Department of Neurosurgery, Thomas Jefferson University and Jefferson Hospital for Neuroscience, Philadelphia, PA
b Department of Ophthalmology, Thomas Jefferson University Hospital, Philadelphia, PA, USA

ARTICLE INFO

Article history:
Received 29 November 2014
Revised 31 January 2015
Accepted 15 February 2015

Keywords:
Retinoblastoma
Intraarterial chemotherapy
Ophthalmic artery
Middle meningeal artery
Stenosis

ABSTRACT

Retinoblastoma is a deadly eye cancer in children, leading to death in 50%–70% of children in undeveloped nations. Unfortunately, this aggressive tumor is the most common intraocular malignancy worldwide. For the last 2 decades, intravenous (IV) chemotherapy has been the mainstay of treatment for retinoblastomas. This route has provided improved control in retinoblastoma, with sparing of the eye and vision in some cases. More recently, intra-arterial chemotherapy (IAC) has become the first line treatment for advanced and refractory retinoblastoma in many centers worldwide. The advances in treatment along with early tumor detection are responsible for the favorable prognosis found in developed nations. IAC classically uses the ophthalmic artery (OA) in attempt to deliver the maximal dose of chemotherapy while minimizing systemic complications. However, direct catheterization of the ophthalmic artery (OA) is not always possible. The purpose of this article is to describe a case where the OA has been thrombosed and an alternative access route using the middle meningeal artery (MMA) was used.

© 2015 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Background

Retinoblastoma is a deadly eye cancer in children, leading to death in 50%–70% of children in undeveloped nations [1]. Unfortunately, this aggressive tumor is the most common intraocular malignancy worldwide. For the last 2 decades, intravenous (IV) chemotherapy has been the mainstay of treatment for retinoblastomas [1–4]. This route has provided improved control in retinoblastoma, with sparing of the eye and vision in some cases. More recently, intra-arterial chemotherapy (IAC) has become the first line treatment for advanced and refractory retinoblastoma in many centers worldwide [1–4]. The advances in treatment along with early tumor detection are responsible for the favorable prognosis found in developed nations. IAC classically uses the ophthalmic artery (OA) in attempt to deliver the maximal dose of chemotherapy while minimizing systemic complications. However, direct catheterization of the ophthalmic artery (OA) is not always possible. The purpose of this article is to describe a case where the OA has been thrombosed and an alternative access route using the middle meningeal artery (MMA) was used.

Case presentation

The patient is an infant who was diagnosed with advanced right-sided retinoblastoma. The patient was a candidate for IAC. The patient was taken to the interventional suite for initiation of IAC.

Treatment

The technique used in the first two sessions of IAC was the direct OA catheterization. This technique consists of superselective catheterization of the ostium of the ophthalmic artery under fluoroscopic guidance for focal delivery of chemotherapy. At the time of the third IAC session, the angiography demonstrated complete occlusion of the OA (Fig. 1). Therefore, we aimed to catheterize the OA through the middle meningeal artery (MMA) if the communicating branch between the two systems is sufficiently developed to permit it.

Selectively, the right external carotid artery (ECA) was catheterized and the microcatheter was guided into the MMA via the internal maxillary artery (Fig. 2). An angiogram performed then showed collaterals from branch of the MMA reconstituting completely the ophthalmic artery all the way to the central retinal artery (Fig. 3a). Superselectively with a Prowler 10 and Synchro 10, the branch of the MMA going all the way to the OA was catheterized. Then, intraarterial...
infusion of melphalan 7.5 mg over half an hour was performed, followed by another half an hour of IA infusion of topotecan 1 mg.

Control angiogram with selective right ECA injection showed patency of the collateral to the OA (Fig. 3b). The IAC was well tolerated with no local side effects. No severe systemic complications including neutropenia, vomiting, or alopecia, which commonly occur with IV chemotherapy were noted. The patient was successfully treated and discharged home without any complications. The tumor has completely regressed and enucleation was avoided. He continued to follow with his Ophthalmologist without any evidence tumor recurrence at 1-year follow-up.

Discussion

IAC came as a solution for the low success rate of chemoreduction in treating advanced retinoblastoma particularly when vitreous metastasis was present [5]. Even more, IAC offers the advantage of delivering a higher dose directly to the tumor bed with minimal systemic toxic effects, reducing therefore the rate of cancer's recurrence [6]. Direct OA catheterization with microcatheter can achieve a technical success rate of 98.5%–100% in expert hands [2]. This presumed combination of efficacy, safety, and precision makes IAC very appealing for dealing with retinoblastomas [1]. OA catheterization technique has been demonstrated to be successful as primary therapy [2,3,7], especially with advanced disease, in bilateral cases [8], and in refractory cases [2,7,8].

However, direct OA is not always feasible for a multitude of reasons. First, the size of the OA in children can be too small for catheterization [3]. Second, the major blood supply to the globe might be derived from a different artery, and finally, the angle between the OA and the ICA can make the catheterization challenging [3]. Furthermore, if the first attempts have been successful, future treatment via direct catheterization is not guaranteed for a variety of reasons, which include vasospasm [3] and complete thrombosis of the OA as seen in the present case. In these problematic situations, an alternative access route that ensures the same fruitful outcomes as with direct OA catheterization is needed. One solution would be the access to the globe by making use of the communication between the ECA and the OA. A retrospective review of 110 retinoblastomas treated by at least 1 infusion by a vascular route other than direct OA catheterization, reported a survival rate of 92.9% (13/14 patients) with a tumor control in 17/18 eyes after a median follow-up of 17.5 months [3]. The alternative routes included catheterization through the MMA and balloon-assisted infusion.

The MMA may form an anastomosis with the lacrimal artery soon after it branches off the OA. This branch, called the orbital branch of the MMA, enters the orbit through the lateral aspect of the superior orbital fissure, and can be in many cases suitable for catheterization. The chemotherapy drugs can be injected to fill the lacrimal artery and reflux into the OA, resulting in flow of chemotherapy to the eye through the normal ciliary and retinal circulation [3]. Rarely, the MMA may give rise to the origin of the OA, which can be another alternative route for IAC delivery to the eye [9,10]. In conclusion, the alternative routes to direct OA catheterization have been proven safe, feasible, and able to achieve excellent tumor control [3].

References

Fig. 2. Angiogram showing the catheterization of the right external carotid artery where the microcatheter was guided into the middle meningeal artery via the internal maxillary artery.

Fig. 3. a) Angiogram showing the catheterization of the branch of the middle meningeal artery (where delivery of the chemotherapeutic regimen was performed) with retrograde filling of the ophthalmic artery. b) Control angiogram showing patency of the collateral to the ophthalmic artery.