Arterial Anastomosis in the Tongue

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Purpose: Radical surgery for neoplasms of the tongue can endanger at least 1 lingual artery, threatening the survival of the remaining tissue and the recovery of speech and swallowing. Although there is little anastomosis in the substance of the tongue, this study investigated whether arterial anastomoses outside the tongue could provide collateral circulation to protect the surviving tissue.

Materials and Methods: Parts of 9 embalmed cadaver heads were examined. In 2 specimens, the arteries had been previously injected with latex and India ink. In the remaining, a mixture of latex and India ink was injected into the lingual artery at its origin on 1 side. Five injections were successful.

Results: There was considerable variation in the course and distribution of the lingual arteries. Arteries did not cross the midline of the tongue, but actual or potential anastomoses could be seen round the base of the tongue, in the floor of the mouth, and with facial artery branches. After the experimental injections, the mass filled the lingual artery and its branches on the injected side, but also reached the trunk and main branches of the opposite side.

Conclusion: A mass injected into the lingual artery of 1 side can reach the trunk and territory of the lingual artery of the opposite side. In life, it is likely that a similar collateral circulation would exist. Some clinical literature supports this conclusion, but preoperative arteriography might be a reasonable precaution.

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The main arterial blood supply to the tongue is derived from the lingual artery and its branches on each side. This vessel arises from the external carotid artery, forms an upward loop, and then passes forward into the substance of the tongue above the hyoid. At the anterior border of the hyoglossus, it turns upward and becomes continuous with its terminal branch, the deep artery of the tongue. The deep artery lies on the inferior surface of the tongue, close to the frenulum, and terminates in the region of the tip.

There is renewed interest in head and neck surgeons in the lingual artery and its connections because of recent advances in surgical approaches for the resection of tongue tumors, with or without postoperative reconstruction. Open and transoral endoscopic approaches to tongue resection must consider the neurovascular supply of the tongue.[1] As the plane of surgical resection deepens, the lingual artery is at risk of injury requiring ligation unilaterally or bilaterally. Maintaining an adequate arterial blood supply to the remaining lingual remnant and tip after resection is of paramount importance to minimize the risk of tissue necrosis and maximize the patient's functional outcome in speech and swallowing.

Anatomic textbooks agree that there is anastomosis between the left and right deep arteries at the tip of

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the tongue. Apart from this, Romanes[2] claimed that "there is little communication between the arteries of the two sides," but Standring[3] described anastomoses between the suprahyoid and dorsal lingual branches of opposite sides, between the sublingual arteries of opposite sides, and between the sublingual artery and branches of the facial artery of the same side.

Based on these descriptions, the authors hypothesized there might be few connections between the lingual arteries in the substance of the tongue, but there could be connections outside which would allow a collateral circulation to the tip of the tongue in the event of flow in either or both lingual arteries being interrupted.

To test this hypothesis, the authors dissected cadaver heads from bodies in which the arteries had been injected with a combination of latex and Indian ink in a 10-mL syringe to look for obvious connections between the lingual branches and with local arterial systems. To test whether these connections were potentially functional, the authors prepared a separate series of specimens in which a mass of latex and India ink mass was injected into the lingual artery of 1 side at its origin and looked for any filling of the lingual artery or its branches on the opposite side, especially toward the tip of the tongue.

Materials and Methods

All cadaveric studies were carried out in accordance with the provisions of the Anatomy Act of 1984 and subsequent revisions under the Human Tissue (Scotland) Act 2006, part 5. All procedures were carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki). Two half heads and 7 intact heads were selected from the regular cadaver stock from the Body Donation Programme in the Laboratory of Human Anatomy, University of Glasgow (Glasgow, UK). No obvious craniofacial deformities were identified. All donor specimens had been embalmed by standard procedures in which a formaldehyde-based solution was injected through 1 common carotid artery with the cannula directed caudally.

The 2 donor half heads came from bodies in which the arteries had subsequently been injected through the same cannula with a mass of latex and India ink to visualize the arteries for a course in the anatomy of plastic surgery. This mass is especially suitable because it produces a cast that is easily seen, pliable at dissection, and still visible after chemical clearing. These 2 donor half heads were used to become familiar with the course, branches, and connections of the lingual artery using the figures in *Grant's Atlas of Anatomy*[4] as a guide.

The 7 intact donor heads had been routinely embalmed (as previously described), with no latex or India ink added. Initially, the lingual artery was fully exposed at its site of origin, ensuring minimal disruption to adjacent structures. A plastic cannula was inserted into the vessel and tied securely in place, ensuring no obstruction to flow through the cannula or vessel. The solution used was physiologic saline 100 mL with a trace of ammonia injected into the lingual artery immediately before the colored mass to neutralize residual formalin and decrease the chance of the latex injection setting prematurely. The latex in the injection mass was colored to a full black with filtered India ink and diluted to the consistency of milk. The mass was injected from a 20-mL plastic syringe using hand pressure and without a pressure gauge.

In 2 cases, the injection failed to flow. In the others, it appeared rapidly at points on the surface of the tongue and at the open end of the contralateral lingual artery. At that point, injection of the fluid was stopped. The lingual arteries were tied off, the cannula was removed, and the specimens were left for 1 week to allow for hardening of the latex.

When the superficial dissection of the arteries was complete, the body of the tongue was sectioned transversely to study the distribution of the injection mass. The tip was sectioned horizontally. Sample sections were cleared by the Spalteholtz technique[5] to look for the terminal branches of the arterial system.

Results

The lingual artery (Fig 1) arose from the external carotid artery in all 16 dissected half heads. It looped over the greater horn of the hyoid and traveled forward along the upper border of the hyoid, deep to the hyoglossus. At the anterior border of the hyoglossus, it turned upward and became characteristically tortuous. The main branches arising from the lingual artery were the suprahyoid and dorsal lingual branches, the sublingual artery, and the deep artery of the tongue.

The suprahyoid branch was found to arise from the lingual artery close to its origin. It ran forward, parallel to, and just below the lingual artery and then crossed the thyrohyoid toward the upper border of the thyroid cartilage. The dorsal lingual branches also arose close to the origin of the lingual artery. One was found deep to the hyoglossus as it turned upward and medially to reach the posterior third and dorsum of the tongue. The sublingual artery was found to arise at the anterior margin of the hyoglossus, running forward toward the sublingual gland. In this specimen, it was very small. The deep artery of the tongue, the terminal branch of the lingual artery, passed forward between the genioglossus and the inferior longitudinal muscle to reach the tip of the tongue. Large branches climbing through the tongue muscle to reach the dorsum also were found.