



Investigating the tympanic membrane blood supply: A preliminary cadaver study

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ABSTRACT

Objectives: This study aims to investigate the arterial and venous vascularization of the tympanic membrane (TM) with colored vessel embalming procedure in fresh cadaver heads, as a guide for minimally invasive tympanoplasty procedures.

Patients and Methods: This study was performed on two fresh frozen cadaver heads (4 ears, 1 male, 1 female). After vessel embalming procedure the TM was examined with rigid endoscopes and the mini vascular plexuses of the TM and external auditory canal were observed.

Results: There is increased vascularization of the posterior superior part of the TM, and the main blood supply derives from the malleolar region. The posterior half of the tympanic membrane has richer perfusion compared to the anterior half.

Conclusion: Awareness of the vascular pattern of the TM allows modification of manipulations during tympanoplasty; the poorly vascularized anterior part of the TM must be protected for successful graft healing.

Keywords: Cadaver ear; tympanic membrane; tympanoplasty; vascularization.

Tympanic membrane (TM) reconstruction is used in patients with chronic otitis media. A perforated tympanic membrane causes recurrent infections and successful graft healing after TM reconstruction is the main purpose of treatment in these patients.^[1] Furthermore, better hearing can be achieved with a repaired TM.^[2] Numerous types of materials are used for graft material and many surgical techniques are performed to achieve success in TM reconstruction surgery. Autologous materials such as temporalis fascia or cartilage grafts have been commonly used.^[3] One of the key considerations in graft healing is blood supply of the TM and neovascularization.

In last two decades, endoscopic transcanal TM reconstruction surgery has become popular

with surgeons. This surgical procedure is less invasive and cosmetic outcomes are better when compared with classical tympanoplasty. This procedure has certain surgical steps.^[4] Elevation of a tympanomeatal flap and dissection of the annulus are one of these. Many surgeons prefer radial incisions that start from the superior part of the annulus to create an anteriorly based tympanomeatal flap. Large incisions help surgeons place the graft. On the other hand, they may harm vascular structures as well. During these steps, protecting the main blood supply of the TM is essential for graft healing. Hence, understanding of the anatomic structure and blood supply of the TM gives surgeons a chance to perform minimally invasive procedures. In our study, we aimed to investigate the arterial

Received: July 04, 2017 Accepted: January 26, 2018

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Doi: <http://dx.doi.org/10.5606/Tr-ENT.2018.92972>

and venous vascularization of the TM with colored vessel embalming procedure in fresh cadaver heads.

PATIENTS AND METHODS

This study was performed on two fresh frozen cadaver heads (4 ears, 1 male, 1 female) in November 2016 in the Anatomy Department of Ege University Medical Faculty. The study was conducted in accordance with international ethical standards.

Procedure and Instrumentation

The embalming method that first described by Bilge and Celik^[5] was used; first, the common carotid and vertebral arteries and internal jugular veins were detected. After bilateral cannulation of common carotid arteries and internal jugular veins, both vasculatures were rinsed with tap water injections. Other open vasculatures detected during water injection were clamped to stop and control leakage. 200 mL of modified Larssen solution (MLS) was injected via the cannulated vessels to embalm the specimen before filling arteries and veins with colored epoxy (Biodur E20 plus red and blue; Biodur Products, Heidelberg, Germany).

A total of 80 mL of blue and 50 mL of red epoxy mixtures were injected via the cannulas through the internal jugular veins and common carotid arteries respectively. After the embalming procedure, the TMs were examined with rigid endoscopes through the external auditory canals. A high definition monitor and camera (Karl Storz, GmbH & Co. KG, Tuttlingen, Germany) were used, and videos were recorded on a computer hard disc. Xenon light source (Karl Storz® Xenon Nova 175, Karl Storz, GmbH & Co. KG, Tuttlingen, Germany), and a 4 mm (18 cm length) Hopkins-rod lens rigid 0° endoscope (Karl Storz® Endoscopes, Karl Storz, GmbH & Co. KG, Tuttlingen, Germany) were used.

RESULTS

We observed that vascularization of the posterior superior part of the TM and main blood supply derives from the malleolar region. The posterior half of the tympanic membrane has better perfusion compared to the anterior half (Figure 1). Observations were similar in all four ears.

DISCUSSION

Blood supply and neovascularization play a key role in graft healing after surgery. Previous studies have shown the dynamic vascularization of the TM.^[6,7] A study investigating TM's dynamic vascularization with Fluorescein angiography revealed that the posterior half of the TM derived its blood supply mainly from the malleolar artery and the posterior half had better blood perfusion compared to the anterior half, with the blood supply to the anterior half of the TM appearing to come mainly from blood vessels branching from the annular ring with consistently less perfusion than the posterior half.^[6] Another study has shown that the malleolar artery is the major blood supply of the posterior half of the drum, which is better perfused than the anterior half. The anterior half of the drum is apparently supplied by the smaller radial branches that enter from around the annulus.^[7]

In our study, the cadaver embalming technique and HD imaging with endoscopes gave us a chance to observe the mini vascular plexuses of the TM and external auditory canal. Defining vascular characteristics of the TM gives



Figure 1. Endoscopic view of mini vascular plexuses of the tympanic membrane and external auditory canal.

us a guide for minimal invasive procedures. Incisions that are made on the posterior side of the TM, the malleolar region of the annulus and poorly vascularized anterior side of the annulus are spared. Vascularization is preserved and the better blood supply may play a role in neovascularization and increase the cartilage graft success rate.

In conclusion, in this cadaveric study, we observed the arterial and venous vascularization of the TM with colored vessel embalming procedure in fresh cadaver heads. We suggest that being aware of the vascular pattern of the TM, gives a chance to modify manipulations during tympanoplasty, and the poorly vascularized anterior part of the TM and malleolar region of the annulus must be protected for successful graft healing.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

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