Abstract

Objectives: Corrosion casting enables visualization of blood vessels without obstruction by overlying bone and soft tissue. Our aim was to demonstrate the use of this technique in a non-human model (pig, Sus scrofa domesticus).

Methods: Yorkshire piglets were anesthetized and their vascular system was perfused with methyl methacrylate (MMA) solution. After polymer hardening, the temporal bone was dissected. The external auditory canal, middle ear, and cochlea were corroded to expose underlying casted blood vessels. These structures were then imaged under light and electron microscopy.

Results: The vascular anatomy is demonstrated in incredibly fine detail. The convolutions, anastomoses and overall architecture are visible in a three-dimensional configuration, free of interposing soft tissue and bone.

Conclusions: Corrosion casting is useful for describing the vascular anatomy of the ear in detail. This technique could be employed to study the effect of various experimental interventions on the vascularity of the ear.

Introduction

Temporal bone vasculature has traditionally been studied using radiographic imaging or schematic textbook drawings. Fresh cadaveric specimens are unfortunately a scarce resource and are not very useful for studying blood vessels. This is due to difficulty isolating these vessels from surrounding tissues and bone, as well as the fact that fine vessels are often destroyed by standard dissection techniques. Specifically, the otic capsul is very small and difficult to access because it is comprised of very dense bone.

We demonstrate here a technique which offers a method of visualizing the vascular network of the temporal bone in its original architecture, from the macroscopic to electron microscopic perspective.

Methods and Materials

Institutional ethics approval was obtained. Five animals were placed under general anesthesia and their vascular supply was injected with MMA solution. To do this, a sternotomy was performed and the aorta and superior vena cava were cross-clamped, cannulated and connected to a cardiac bypass machine. The vascular circuit was cleared using heparinized saline and MMA polymer solution with a blue pigment (Batson's #17 monomer base solution, Probase Cold monomer and Batson's Promoter) was perfused. Animal heads were harvested and placed on ice whilst the resin hardened during an exothermic reaction.

After the resin hardened, the temporal bone was harvested. Soft tissues were dissected and a high speed otologic bur used to identify and then isolate deeper structures, analogous to a temporal bone dissection study. Harvested bones were corroded in alternating solutions of warmed 16 % potassium hydroxide and 2 % hydrochloric acid over a period of 4 to 8 weeks until all bone and soft tissue was corroded. Corroded specimens were imaged under light and scanning electron microscopy (SEM).

Results

At various stages of the dissection, portions of the vascular anatomy were macroscopically visible in the gross specimen due to the blue pigment. This included the soft tissue structures around the pinna, external auditory canal and tympanic membrane. These would not otherwise be macroscopically visible thus allowing guided dissection of certain tissues.

SEM of the cochlea revealed a highly-convoluted, well-organized vascular network with arterioles and venules in the osseous spiral lamina. Turn of the cochlear was clearly visible. The degree of vascularity suggests that the cochlea must have a high metabolic rate and that hearing is likely dependent upon this intricate vascular arrangement.

The tympanic membrane had a highly interwoven mesh of vessels mirroring its tri-laminar structure. The skin of the external auditory canal was also intensely vascular, consisting of two veins and one arteriole arranged in a “tram track” configuration.

Discussion / Conclusions

The vascular supply of the ear and temporal bone is likely responsible for many pathologic processes involving hearing and balance.

This model of examining the vasculature of the temporal bone offers an accurate, reproducible and detailed method of studying both normal anatomy and pathological disorders such as trauma, infection, cochlear implantation and ischemia. Further analysis of stereoscopic pairs of SEM images can ascertain greater detail about these structures such as vessel length, caliber, branching patterns, angularity and layering.

References