The Blood Supply of the Rat Mandible [1]

DONALD F. HUELKE AND WALTER A. CASTELLI [2]
Department of Anatomy, The University of Michigan, Ann Arbor, Michigan

ABSTRACT The blood supply of the rat mandible was studied in 12 adult animals using four techniques. Eight animals were injected with a cinnabar, mercury, zinc oxide mixture (Teichmann's paste) for dissection and for cleared specimens, two with radiopaque material, and two others with India ink. Findings indicate that the coronoid, condylar, and angular processes of the mandible are supplied by vessels which are primarily concerned with the nutrition of the muscles that attach to these areas, and not from the inferior alveolar artery. The inferior alveolar artery supplies the body of the mandible, teeth and adjacent structures. After entering the mandibular foramen this artery bifurcates beneath the third molar tooth. The larger inferior stem passes downward and backward to supply multiple branches to the pulp of incisor tooth and branches to the periodontium about this tooth. The superior stem passes forward beneath the apices of the molar teeth to supply them and the adjacent tissue. The venous drainage of the bone varies — the coronoid and condylar processes drain downward into a confluence of venous channels about the apex of the incisor tooth. Veins of the molar teeth and supporting structures pass through the bone into gingival veins. Concentrations of venous channels primarily draining the angle and condyle are found along the inferior border of the angle and above, where the angular process joins the body proper.

The blood supply of the mandible has certain unique features which are important for experimental procedures and for the study of certain clinical problems. Emphasis has been placed on the blood supply of the temporomandibular joint and articular disc by Cohen ('55), Griffen ('59), Boyer et al. ('64), and Bernick ('62). The vascularity of the teeth and periodontium also has been studied by various investigators (Keller and Cohen, '55; Schuback and Goldman, '57; and Bernick, '60). In a few reports the distribution of only the inferior alveolar artery was studied (Boyer and Neptune, '62; Perint, '49). In most studies only the vascularity of certain areas of the mandible (joint, disc, condyle, teeth, and periodontium) was reported and a variety of laboratory animals were used. Cohen ('59a, b, '60) has studied the arterial supply and venous drainage using human, cat, dog, and monkey specimens. More recently Castelli ('63) has described the blood supply of the entire human mandible, and Castelli and Huelke ('65), the vascularity of the monkey mandible.

It is the purpose of this paper to describe the details of the arterial supply and venous drainage of the rat mandible.

MATERIALS AND METHODS

Twelve adult Wistar rats were used in this experiment. The animals were anesthetized by pentobarbital NCl intraperitoneally. The ventral body wall was opened and the abdominal aorta and the inferior vena cava localized. The animals were completely bled out by a small incision in each of these vessels. A hypodermic needle was then inserted into the abdominal aorta, passed cranially so that the tip of the needle was in the thoracic aorta, and tied in place to prevent outflow of the injection material. A metal syringe was attached to the needle and adequate hand pressure forced the injection medium through the upper arterial tree. Eight rats were injected with a cinnabar, mercury, zinc oxide mixture (Teichmann, cited by Schwering, '52) to study the arterial supply of the mandible, particularly the coronoid process, the condyle, and the area of the angle. Two additional animals were injected with radiopaque material (Reiner and Rodriguez, '57) to study the same re-

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[2] Present address: Dr. Walter A. Castelli, Department of Anatomy, University of Concepcion, Chile.

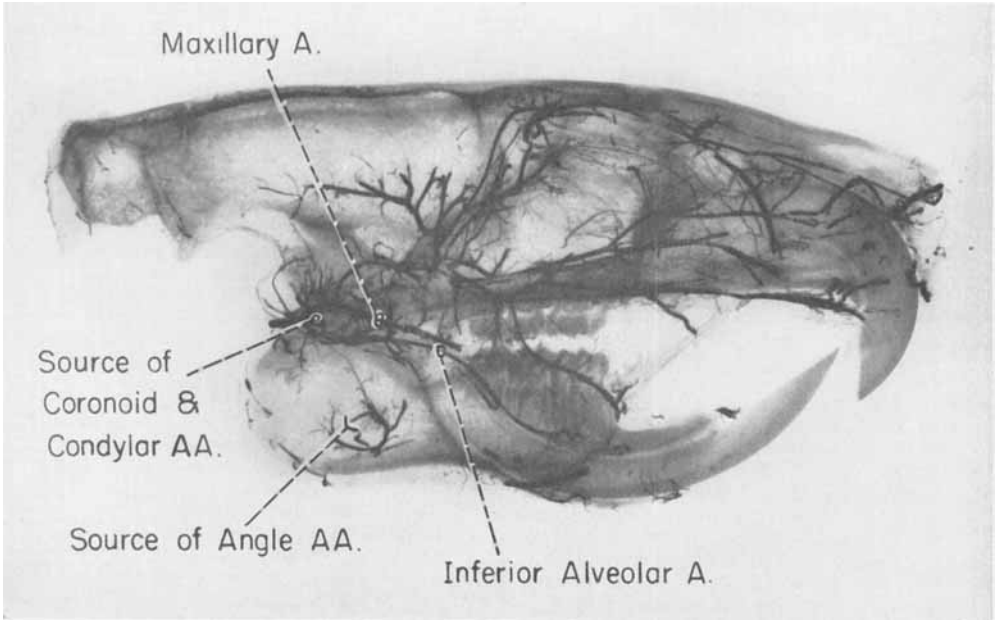

Fig. 1 Radiograph of the deeper arteries of the rat head after most of the soft tissue was removed.

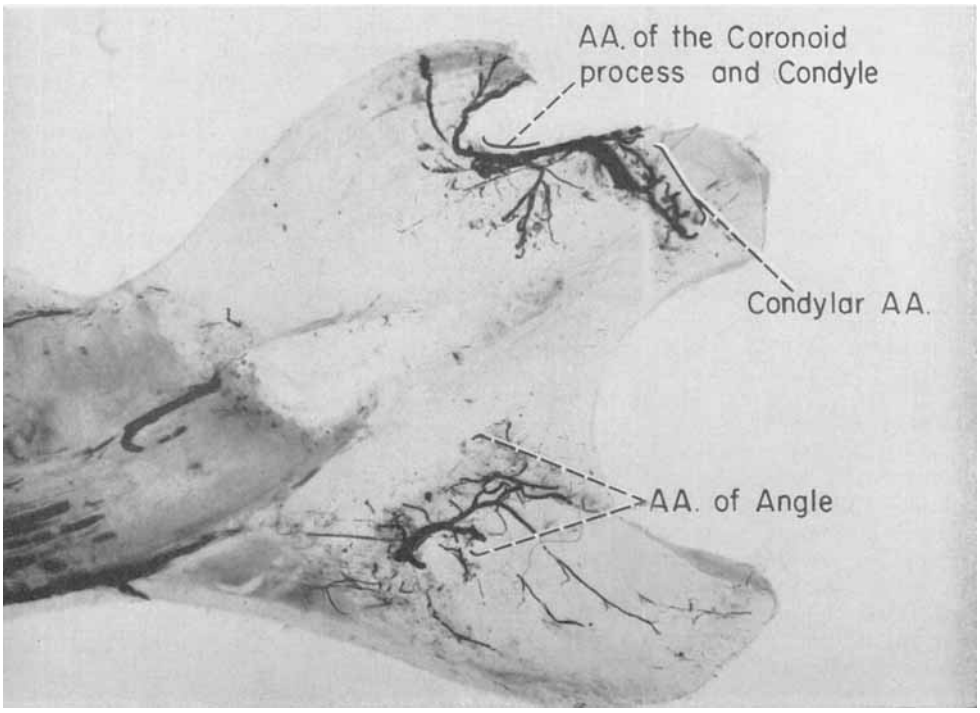

Fig. 2 An arterial bridge linking the coronoid and condylar processes. The blood supply of these processes and the area between them comes from this artery. (Teichmann's paste injection, decalcified and cleared.)

gional blood supply. Capillary vessels and the distribution of the veins were studied in two specimens injected with 25% aqueous solution of India ink.

The heads injected with Teichmann's paste were cut sagittally; the half heads of one side were carefully dissected to visualize the extramandibular arterial branches about the coronoid process, condyle, and angle. The mandibles of the remaining half heads were removed, cleaned of all soft tissue including the periosteum, decalcified and cleared following, in general, the Spalteholtz technique (Spalteholtz, '24). The mandibles of the specimens injected with India ink were similarly treated. Multiple roentgenograms of the specimens injected with the radiopaque material were taken; one before dissection, the second and third as the more superficial vessels were removed, and the fourth when the mandible was completely devoid of soft tissue.

RESULTS

The arteries of the coronoid, condylar, and angular processes arise from vessels which are closely related to the muscles attaching to these specific processes. These vessels are deep in the muscles and tendons and are adjacent to the periosteum. A general view of these arteries is well demonstrated in the roentgenogram (fig. 1).

An arterial bridge links the condyle and the coronoid process; branches radiate outward from this bridge to pass onto the surface of the coronoid process and the neck of the condyle (fig. 2). After reaching the coronoid process the branches of this artery turned to pass parallel to the main axis of the process adjacent to the periosteum (fig. 3).

The arteries of the condyle were found at the attachment of the joint capsule, in the area of the condylar neck (fig. 2). These vessels are about or in the fibers of insertion of the lateral pterygoid mus-

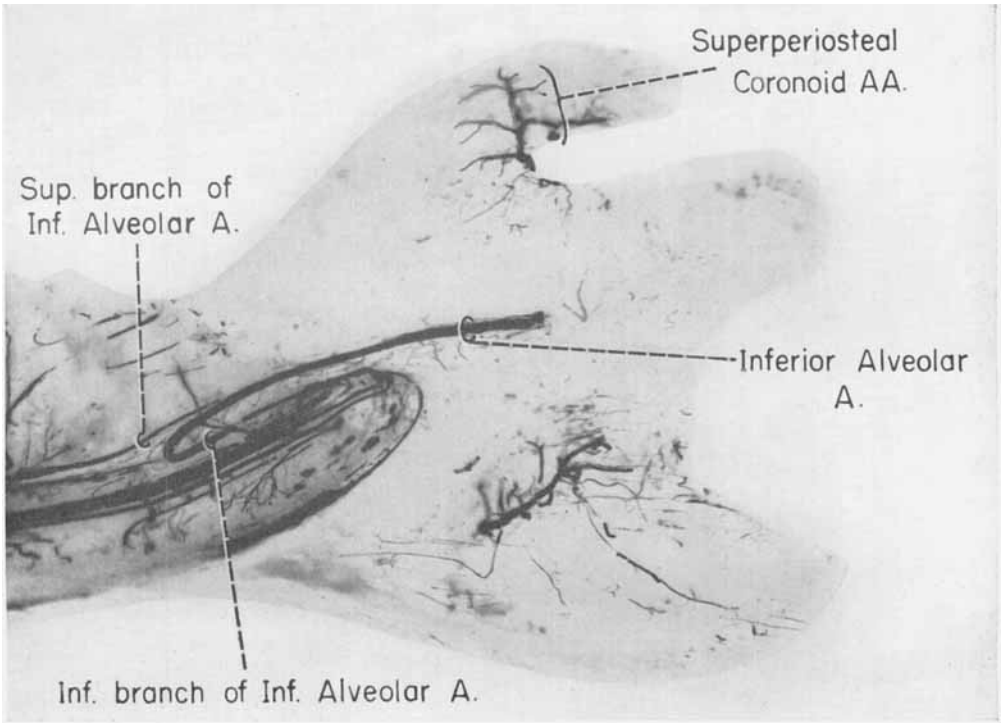

Fig. 3 Position of the arteries of the coronoid and angular processes with the inferior alveolar artery supplying the mandibular body. (Note absence of condylar blood supply since the periosteum was removed.) (Teichmann's paste injection, decalcified and cleared.)

cle. Some of the smaller vessels penetrate the condyle and are distributed within it (fig. 2).

The arterial supply to the angle of the mandible is also seen in figures 2 and 3. These vessels are located mainly on the medial side of the angle lying in a semilunar groove at the base of the angle, close to the periosteum of the bone, deep to the fibers of insertion of the medial pterygoid muscle. In general, the main arteries form a somewhat posteriorly concave vascular arch (figs. 1, 2). From this arch, very small arterioles pass posteriorly close to the periosteum to distribute to the angle (figs. 2, 3).

A Teichmann's paste injection of a specimen wherein all of the muscles and periosteum have been removed from the mandible is shown in figure 4. Here it is apparent that no vessels arising from an intraosseous source (interior alveolar artery) are found in the coronoid process, condyle, or angle of the mandible indicating that the main vessels to these processes pass through the periosteum from the arteries seen in figures 2 and 3.

The body of the mandible and the teeth are supplied by the inferior alveolar artery. After entering the bone at the mandibular foramen this artery courses forward to the level of the last molar tooth where it divides into two branches. The inferior branch, most frequently the larger, turns downward and backward toward the apex of the root of the incisor tooth (fig. 3). It divides into many branches which supply the pulp and periodontal membrane of the incisor tooth and adjacent bone. Those of the pulp are fine, straight, parallel branches (fig. 5). One or two of these arteries continue forward almost to the tip of the pulp cavity (fig. 4). The arteries to the periodontium are multiple tortuous small vessels which, after reaching the membrane, divide into abundant capillaries (figs. 5, 6).

The smaller or superior branch of the inferior alveolar artery continues in a direct line from the parent vessel, above the incisor tooth and beneath the apices of the molar teeth. It divides into branches which supply the molar teeth, periodontium, and bone. In addition, small branches arise from it which pass to the periodontium of the incisor tooth (figs. 3, 5).

The supporting soft tissue and bone of the molar teeth have an additional arterial

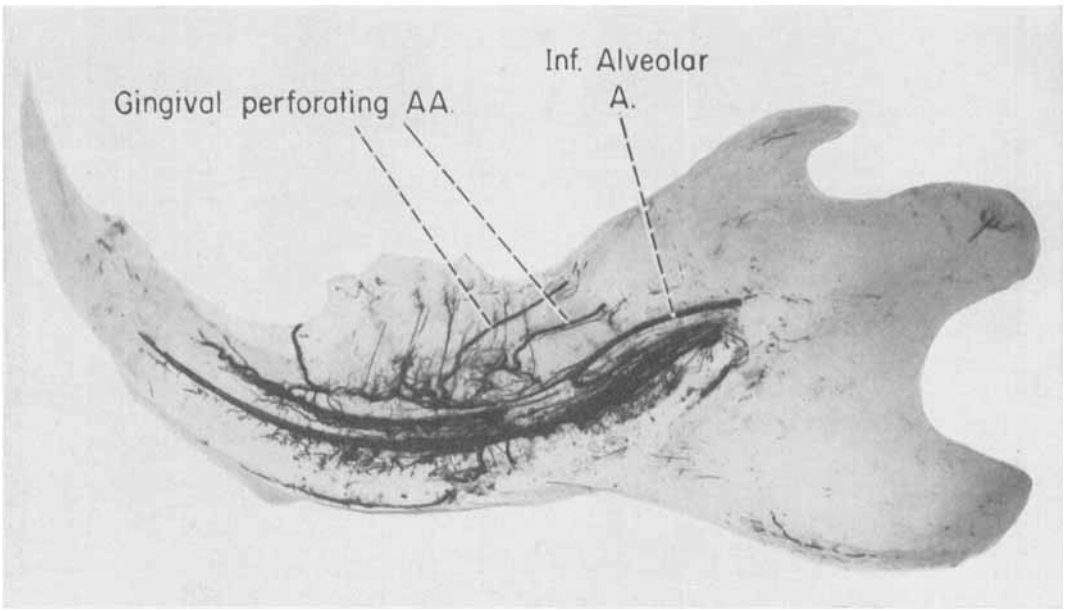

Fig. 4 Rat mandible with muscles of mastication and periosteum removed from the bone. Note that no branches of the inferior alveolar artery supply the condylar, coronoid, or angular processes. (Teichmann's paste injection, decalcified, and cleared.)

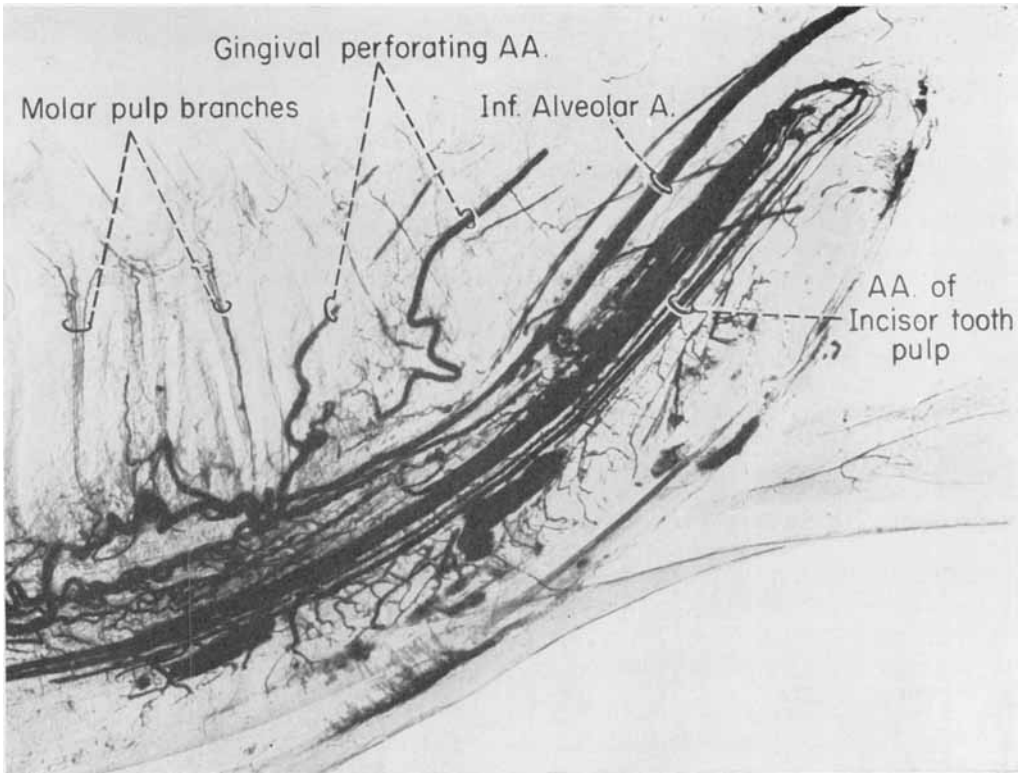

Fig. 5 Branches of the inferior alveolar artery and perforating arteries from the gingiva. (Teichmann's paste injection, decalcified and cleared.)

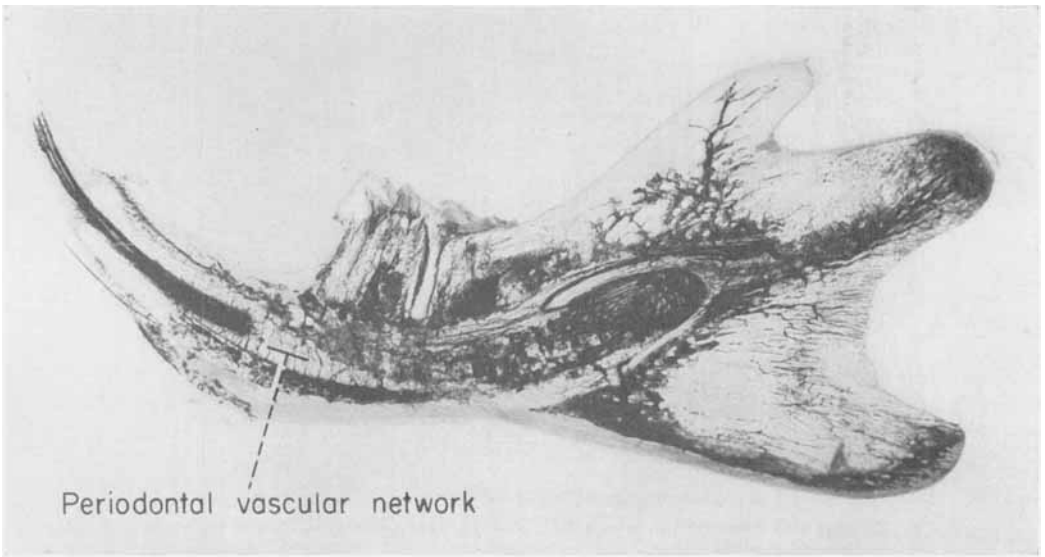

Fig. 6 Capillary arrangement and venous disposition in the rat mandible. (India ink injection, decalcified, and cleared.)

supply — from branches of perforating vessels of the gingiva (figs. 4, 5). These vessels, numbering 2 to 4, are important branches in that they are often large than those arising from the superior branch of the inferior alveolar artery.

The venous drainage of the mandible is clearly seen in figures 6 and 7. These specimens show that the coronoid process has a central vein which generally follows the long axis of the process. This central vein is formed by the anastomoses of smaller capillary vessels and venules. The capillaries appear to follow a course parallel to the main axis of the process but the venules empty into the central vein at nearly right angles (fig. 7). In the condyle, the capillaries form a network immediately beneath the articular surface of the process. The venules course toward the central axis of the neck of the condyle where they coalesce to form one or two main central veins.

In the rat the angle of the mandible is a very thin plate of bone which has a thicker rim of bone around its margin. The thicker regions of bone are shown in figures 6 and 7 by the dark areas — the venous channels located within them. In the thin part of the angle only capillaries and small veins, parallel to one another, run forward to empty into the larger veins found at the junction of the angle with the body proper, and along the inferior border there is an irregular network of venous channels of larger caliber. In side view these vessels demarcate the margins of the angle of the mandible and constitute one of the main drainage areas of the bone.

The venous drainage of the molar teeth and their supporting structures is through channels which pass through bone to the gingival veins. Concentrations of venous channels are seen in the interradicular septa and about the apices of the molar

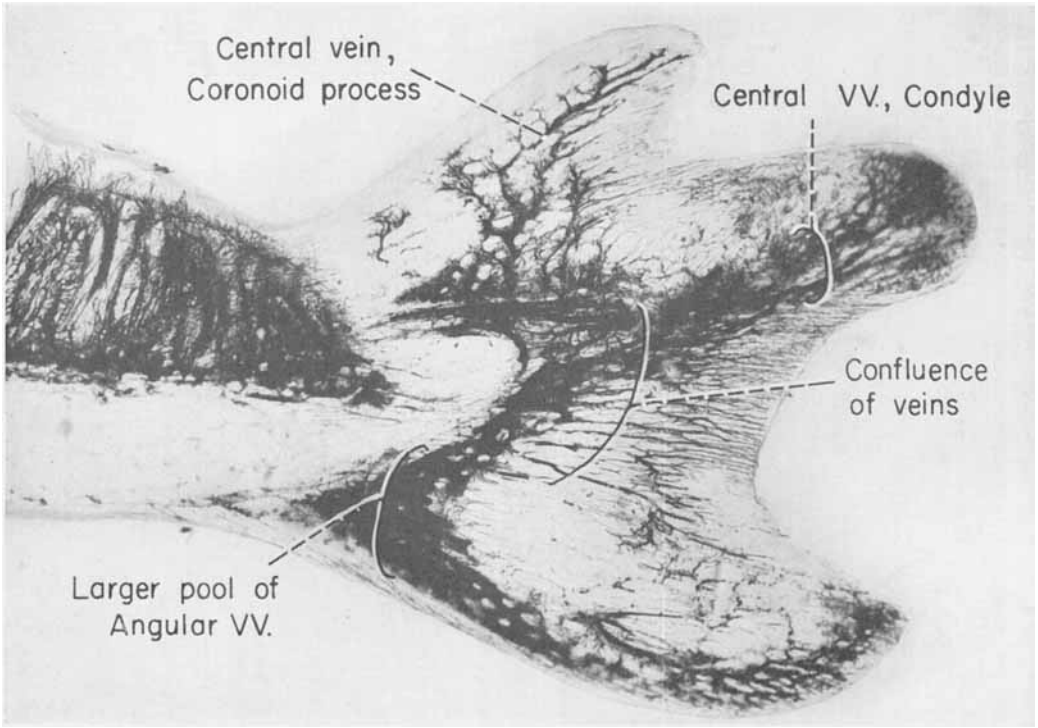

Fig. 7 Venous drainage of the coronoid and condylar processes by central veins. Coalescence of angular veins found about the inferior border and behind the incisor root. Central venous channels in the molar teeth are well shown along with the veins of the septa. (India ink injection, decalcified, and cleared.)

teeth. Venous channels of the pulp are large vessels which pass backward to concentrate about the apex of the incisor tooth. Here there is a confluence of veins from the incisor tooth, coronoid process and condyle from the upper part of the angle (fig. 7).

The drainage of the periodontium of the incisor tooth passes backward to join a confluence of veins at the apex of the tooth and also toward venous channels of the alveolar wall (fig. 6).

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