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ORIGINAL ARTICLE

A new corrosion method (Aycan's method)

Kenan Aycan et al., **A new corrosion method**

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ABSTRACT

Background: As it is known, the anatomy of the vessels is examined by removing the cast of the vessels inside the organs. Generally, liquid material (polyester, takilon, etc.) is injected into the vessels with positive pressure to remove the cast from the vessels of the organs. We built a machine to remove the cast of the vessels inside the organ. We named it corrosion machine.

Materials and methods: Sheep kidneys were used in our experiment. After the kidneys were cannulated, they were placed in the vacuum chamber. With the operation of the vacuum pump, negative pressure was created in the vacuum chamber. With negative pressure, kidneys and its vessels expanded. Takilon or polyester easily entered the vessels of the kidney. The cast of the vessels of the kidney was removed. With this newly developed technique, the anatomy of the vessels whose casts were removed was examined with the naked eye, stereomicroscope or SEM.

Results: The corrosion machine we built can cast the vessels of the organs very well. Takilon or polyester (which we used in our experiment) easily entered the capillaries under the effect of negative pressure.

Conclusions: We think that this method can also be applied to other organs and used in vascular research.

Keywords: corrosion, casting method, takilon, polyester, kidney

INTRODUCTION

The distribution of vessels within organs or the internal structure of organs has been investigated by anatomists for years. For this purpose, radiological methods or plastic injection corrosion methods are used [1–3, 5–19]. In the corrosion method, liquid solutions of substances with solidification properties (Polyester, Nylon, Latex, polyvinyl chloride or Mercox CL-2R, methyl methacrylate, vinyl resin) are prepared [1, 7, 11, 14, 19]. The prepared solution is injected into the vessels of the organs using a syringe or other tools. After these liquid substances solidify in the vessels of the organ, the parenchyma of the organ is melted and the vessels are molded. The removed mold is examined with the naked eye, stereomicroscope or SEM. This method is called the corrosion method. With this method, the anatomy of the circulation within the organs is examined [1–3, 5–19]. The corrosion method has been used for years. In this study, liquid substance was injected into the vessels of the organs under negative pressure (vacuum) with the corrosion machine we newly developed, instead of the syringe. With this machine, the cast of the kidney vessels and glomeruli was shown. The features of the method we use are discussed in the light of literature knowledge.

MATERIALS AND METHODS

We made a machine to use in this experiment (Fig. 1). We named it corrosion machine. It is separated in two main parts is vakum pump (Fig. 1/1) and glass jar (Figure 1/8). Vakum pump reduces air pressure in the glass jar. The glass jar allows corrosion fluid to enter the vessels of the organs at low pressure. The other part of corrosion machine is: air valve for shut or open the air (Fig. 1/2). Manometers of vacuum is shows vacuum in the glass jar (Fig. 1/3). Corrosion liquid chamber (Fig. 1/4) contains corrosion liquid. Vacuum stabilizer (Fig. 1/5) is organizes the vacuum.

Twenty kidneys from 10 adult Akkaraman sheep (12–20 months old and 35–45 kg) were used in this study. Akkaraman sheep have been preferred because they are the widest sheep breed in Türkiye. No alive animals were used in the research for this study. The materials are taken at the slaughterhouse and prepared for research. The volumes of the kidneys were measured according to Archimedes' principles [13]. The average volume of the kidneys was determined to be 60 cc. It was decided to give 10 cc of corrosion fluid to each kidney. When the kidneys were taken from the sheep in the slaughterhouse, we started working immediately. The renal arteries of the kidneys were catheterized. The kidneys were placed in a glass jar (Fig. 1).

Takilon (Ece Boya Kimya Sanayi ve Ticaret A.Ş. İstanbul/Türkiye) was used in 10 of the kidneys to remove the caste of the vessels. Corrosion liquid was prepared by mixing 40 g of takilon (monomethylmetacrylate) powder (polymethylmethacrylate) and 1 g (Oil Red). The prepared solution was placed in the corrosion liquid chamber. Vacuum was adjusted to 20 cm Hg Vac with the vacuum stabilizer in the vacuum room (Fig. 1/7). Air valve is closed. The vacuum pump was started. The kidney and its vessels began to expand due to the negative pressure created in the glass jar. The takilon solution in the corrosion fluid chamber filled the intrarenal arteries of the kidney. 10 cc corrosion fluid was given to each kidney. Negative pressure was terminated by opening the air valve. The vacuum motor was stopped.

Polyester resin (Ece Boya Kimya Sanayi ve Ticaret A.Ş. İstanbul/Türkiye) was used in 10 of the kidneys to remove the caste of the renal vessels. Polyester solution was prepared by adding 100 cc of polyester resin, 2 g of paint, 1 cc of accelerant and 2 cc of catalyst. The prepared solution was placed in the corrosion liquid chamber. The vacuum was adjusted to 20 cm Hg Vac with the vacuum stabilizer. Air valve is closed. The vacuum pump was started. The kidney and its vessels began to expand due to the negative pressure created in the glass bowl. The polyester solution in the corrosion fluid chamber filled the intrarenal arteries of the kidney. 10 cc polyester solution in the corrosion fluid was given to each kidney. Negative pressure was terminated by opening the air valve. The vacuum motor was stopped.

The prepared kidneys were kept at room temperature for 24 hours for polymerization to occur. The polymerized takilon kidneys were kept in an oven in 20% KOH solution at 37°C for 24 hours. Kidneys were washed in tap water and the vessels caste was removed. The polymerized polyester kidneys were placed in Hydrochloric acid (HCL) and kept for 24 hours. Kidneys were washed in tap water and the vessel caste was removed. Photographs of the removed castes were taken. Capillaries were examined both by stereo microscope (Olympus SZX16) and scanning electron microscope (SEM, Zeiss gemini 500) [1].

RESULTS

In our study, we removed the cast of the renal arteries with the method we newly developed (Fig. 3–6). We used the corrosion machine we developed in our study (Fig. 1, 2). When the corrosion machine worked, it created negative pressure in a closed container (glass jar). The negative pressure in the jar expanded kidneys and its vessels. As a result of negative pressure, corrosion fluid (Takilon or Polyester) easily entered the capillaries of the kidney. We used takilon (Fig. 3, 6, 7) and Polyester (Fig. 4, 5) as corrosion fluid by the corrosion machine.

In our study, we used easily available sheep kidneys. We removed the cast of the kidney vessels with our corrosion machine. With this method, we examined the renal arteries and glomeruli with both a stereomicroscope (Fig. 6) and a scanning electron microscope (SEM) (Fig. 7).

If the negative pressure is high (20 cm Hg Vac), the anatomy of the capillaries is disrupted, corrosion fluid fills the kidney parenchyma and the vessels cast do not removed (Fig. 4). The vacuum level can be adjusted with the vacuum stabilizer of the machine. As a result of our experiments, we determined that it is appropriate to adjust the vacuum stabilizer to a maximum of 20 cm Hg Vac. Adjusting the pressure of the corrosion fluid with the corrosion machine we developed is under the control of the researcher.

Before the experiment started, we determined that the average volume of the kidneys was 60 cc by measuring them according to the Archimedes principle. We conducted experiments by giving different amounts of corrosion fluid to the kidneys. As a result of our experiments, we determined that it is appropriate to give 10 cc of corrosion fluid to remove the cast of the renal vessels. If the corrosion fluid given to the kidney is more than 10 cc, the kidney capillaries rupture, the corrosion fluid solidifies in the kidney parenchyma and the vessels do not removed.

With the method we developed, we removed the vessels cast of the kidney and examined its anatomy with the naked eye (Fig. 3–5), and its glomeruli with a stereo microscope and SEM (Fig. 6, 7). The kidney arteries in the casts we removed with this new method were in normal anatomical shape and size.

DISCUSSION

As it is known, the thoracic cavity expands and contracts with the movements of the respiratory muscles. With the negative pressure created in this expansion, air enters the lungs, and in contraction, air leaves the lungs. This event is called inspiration and expiration. Air enters the lungs under the effect of the negative pressure (vacuum) formed in the thoracic cavity [4]. This method we applied was created by making use of the inspiration and expiration mechanism. The working principle of the corrosion machine we have developed is to create negative pressure in a closed container (glass jar) so that the corrosion fluid can easily enter the vessels of the organ. As a result of the negative pressure in the glass jar, the organ in the jar and its vessels expand. Corrosion fluid (takilon or polyester) easily enters the capillaries of the organ. The removed casts preserve the normal anatomical shape and size of the vessels.

We used polyester and takilon to demonstrate the feasibility of the method. These chemicals can be easily found in the market in Turkey. Later, we will try whether other chemicals can be used in this method.

In our study, it has been shown that corrosion fluid easily enters the kidney vessels with negative pressure. The cast of the vessels of the kidney has been removed. We believe that this method can also be applied to other organs.

In known corrosion methods, the prepared corrosion fluid is injected into the vessels of the organs with positive pressure [1–3, 5–19]. In this study, instead of positive pressure, negative pressure was applied to the organs, allowing corrosion fluid to enter the vessels. As a result of negative pressure, the organ and ıts vessels within it expand and the corrosion fluid easily enters the expanded vessels. It is easier to remove the mold of the vessels by applying vacuum instead of using injection. Our method is important in terms of ease of use. For this purpose, the vacuum corrosion machine has been developed by us.

When the sheep were slaughtered, the kidneys were removed immediately. The method was implemented without any delay. No anticoagulant chemicals (Heparin-acetone-coumarin) were used. As seen in our findings, there was no clotting problem. Removing the cast of the glomeruli shows that there is no clotting problem. According to our findings, we think that negative pressure solves the clot problem by expanding the vascular lumen. This result showed that the method can be used in corrosion.

If there is too much corrosion liquid entering the kidney, the capillaries of the kidney rupture and the corrosion liquid fills the parenchyma of the kidney. Cast of the vessels of the kidney cannot be removed as the corrosion liquid hardens within the parenchyma. The amount of corrosion liquid administered to the kidney should only fill the vessels. For this purpose, we calculated the average volume of the kidneys by using Archimedes' principle [13]. We determined that the average volume of the kidneys is 60 cc. As a result of our experiments, we determined that it is appropriate to give 10 cc of corrosion liquid to remove the cast of the renal vessels. If the amount of corrosion liquid given to the kidney is more than 10 cc, it ruptures the capillaries, the kidney parenchyma hardens, and the blood vessels do not come out. The amount of corrosion liquid is controlled from the indicator in the corrosion liquid chamber. Researchers who will use this method must carefully adjust the amount of corrosion liquid to be administered to the organ from which they will be removed.

In our experiment, the negative pressure in the glass jar is observed with a vacuum manometer. If the vacuum applied to the organ is high (for example: 40 cm Hg Vac), the kidney capillaries rupture and cast does not removed. In our study, it was determined that the vacuum applied was appropriate to be around 10–20 cm Hg Vac. The pressure to be applied during the experiment can be adjusted by opening the air valve. More or less negative pressure affects the result of the experiment. As a result, we believe that this method we have developed can be used in anatomy education to examine the anatomy of the vessels of organs.

CONCLUSIONS

In the corrosion machine we have developed, takilon and polyester can be used as corrosion liquid if desired. With these substances, the cast of the vessels can be removed. We believe that other corrosion materials (latex, polyurethane, nylon, etc.) can also be used with this machine.

As a result, the corrosion machine we built can cast the vessels of the organs very well. Polyester or takilon can be used to remove the cast of the vessels of organs with the corrosion machine, we believe that other materials can also be used. We think that if a large Vacuum chamber is built instead of the jar, the vessels and the other cavities of larger organs (liver, lung, etc.) casts can be removed. We believe that this method may be useful for those who want to remove the cast of the cavities.

Article information and declarations

Data availability statement

The data that support the findings of this study are available on request from the corresponding author.

Ethics statement

This study was conducted on sheep cadaver kidneys; it is among the studies that do not require ethics committee approval.

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Author statement

Kenan Aycan: Preparation of the study, data collection and analysis, writing & editing. Fatma Köse: Data collection. Burcu Kamaşak Arpaçay: Data collection, Writing & editing. Tufan Ulcay: Data analysis. Ayhan Düzler: Data analysis and supervision

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Conflict of interest

The authors declare no conflict of interest.

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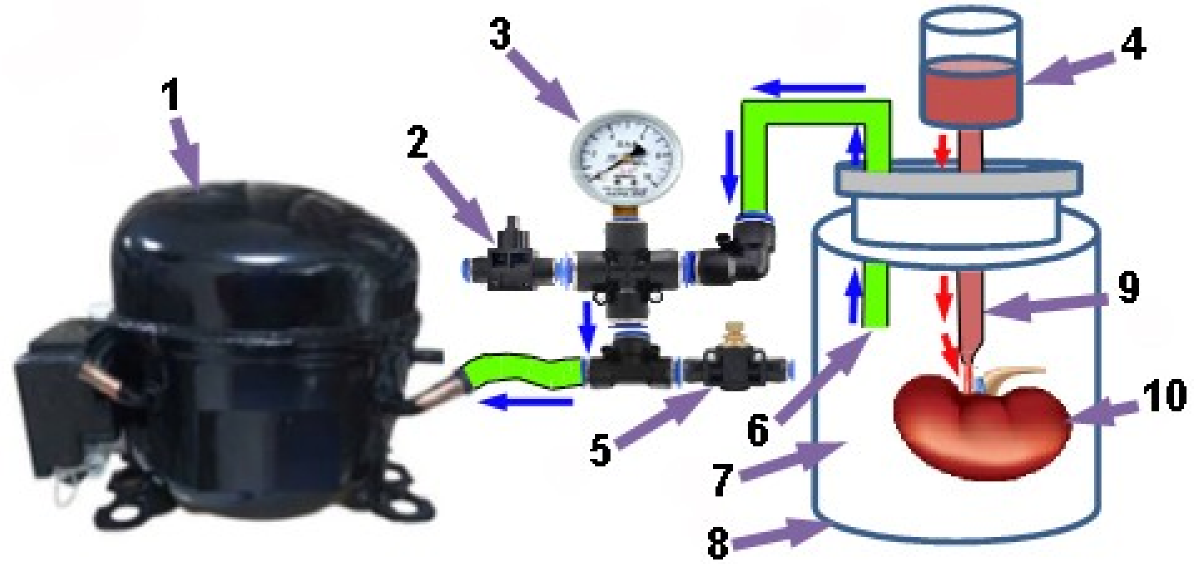

Figure 1. Corrosion machine. Vacuum pump (1), air valve (2), Manometers of vacuum (3), Corrosion liquid chamber (4), vacuum stabilizer (5), Air discharge pipe (6), Vacuum room, Negative pressure (7), Glass jar (vacuum chamber) (8), Corrosion liquid pipe (9), Kidney (10)

Figure 2. Corrosion machine

Figure 3. The cast of the sheep kidney's vessels with takilon

Figure 4. Kidney parenchyma filled with corrosion fluid due to high vacuum at different levels and kidneys whose casts cannot be removed

Figure 5. The cast of the sheep kidney’s vessels with polyester

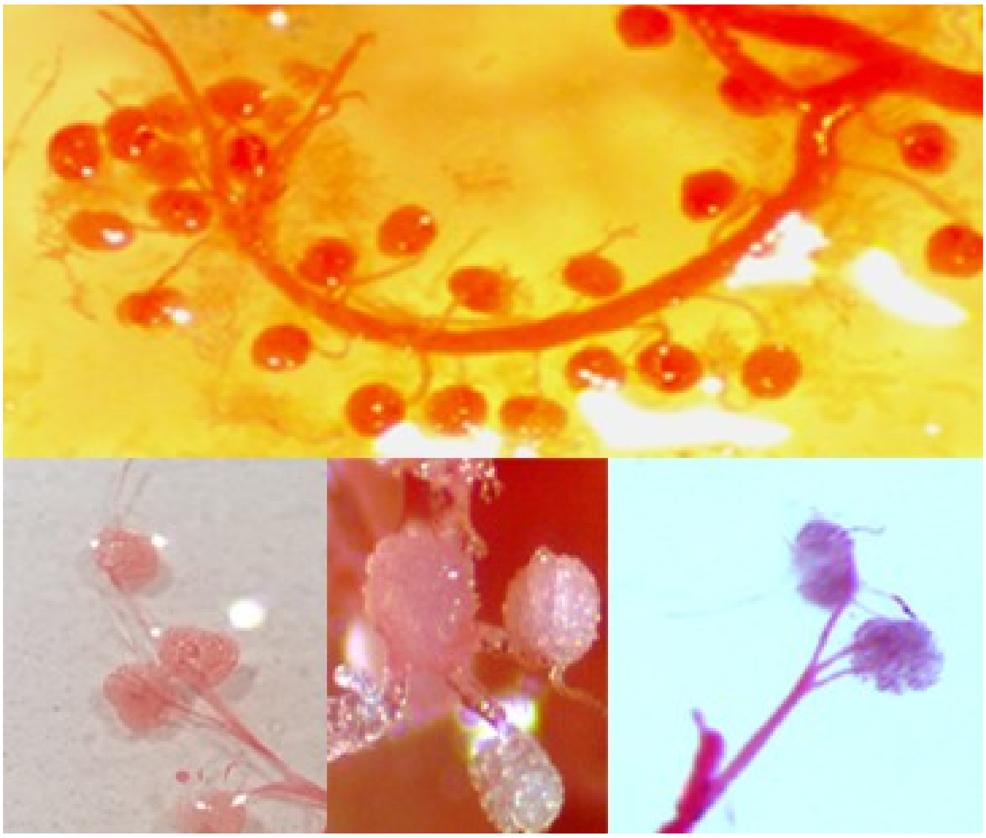

Figure 6. The takilon cast of the glomerules (Stereomicroscopic wievs)

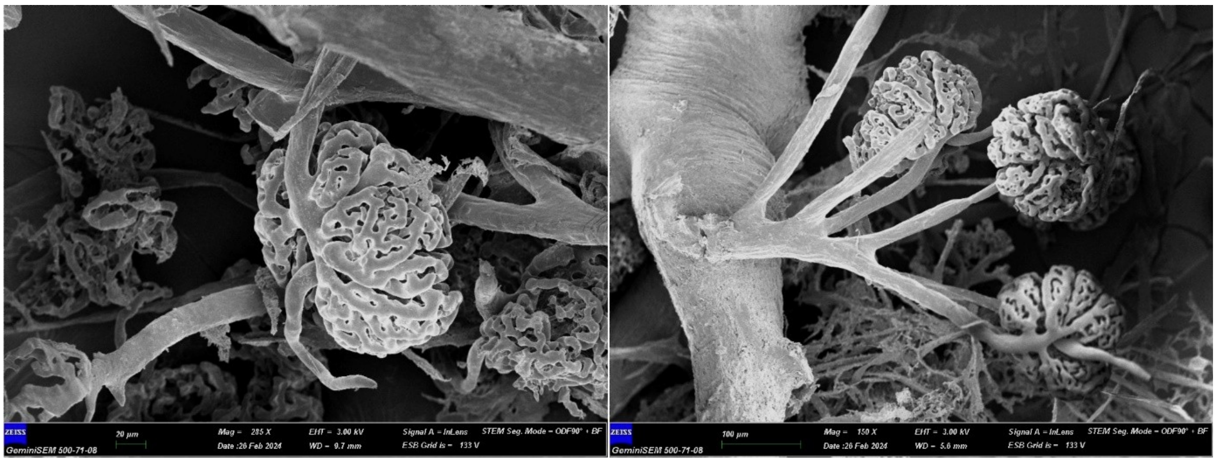

Figure 7. The takilon cast of the glomerules (SEM)