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VISUALIZATION OF BLOOD VESSELS BY CORROSION TECHNIQUE

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Abstract

Corrosion technique is one of the basic and widely used methods of visualization of vascularization of organs in the anatomy of humans and animals. It consists in filling vascular (blood or lymph), wires or cavernous organs material, e.g., injection. Mass based on wax or putty material based on rubber, synthetic resin and subsequently etching the soft tissues. Ultimately obtained castings of these structures. The aim of the study was to evaluate the usefulness of this technique in morphological studies. In retrospect, corrosion technique has been used already in the seventeenth century, however, because of the use of filler materials such as water, liquid dyes, and even air, obtained anatomical specimens were unstable, therefore, did not yield the desired effect of the test. With time, however, the corrosion technician went through some modifications and new solutions in the embodiment and above all in the chemical composition of the filling material. In the twentieth century, they began to use compounds such as polyester resins, methyl methacrylate or polyvinyl chloride, the specific properties of these compounds allowed the visualization and consolidation of fine anatomic structures in the vascular system, the bronchial tree or the bile ducts. Extensive use

of this technique in medicine, veterinary and comparative anatomy of vertebrates underlines its usefulness and the need to use.

Keywords: anatomy, circulatory system, preparations corrosion

1. Introduction

In everyday life, the term "corrosion" is certainly identified with the processes chemicals, metals which they are subject. Of course, the consequence is the formation of rust, as brittle, non-uniform, a brown layer of iron compounds. Generally speaking, "corrosion" to all processes destroy the material (plastic), which consequently causing its disintegration. There are many types of corrosion, for example the atmospheric, chemical, biological. It is worth to point out that the term "corrosion" also found a place in the anatomical terminology. Corrosion technique is one of the most widely used methods of visualizing blood or lymphatic vessels as it allows you to observe their progress in relation to the organ wall. In general, simplification consists in the filling (injection) vessels, ducts, and cavernous organs material injection. This may be derived from the mass of wax or putty, material-based rubber (latex) or a synthetic resin. In a further step and so on injection vessel is carried out gradually etching the soft tissues. For this purpose different concentrations of base (KOH) or hydrochloric acid (HCl). Ultimately, as the final effect obtained is molded tested anatomical structures (Ślusarczyk et al., 2006; Djonov & Burri, (2004).

The corrosion technique comprises the following steps:

1. Preparation of the organ from which the formation of corrosive formulation;
2. The choice of the filling (injection material) with which the post injection;
3. The injection of a suitable, i.e. to fill, for example, vessels;
4. The hardening of the injection material;
5. Digestion of soft tissues, i.e. a process of corrosion;
6. The final processing of the formulation, e.g. washing with water the obtained casting;
7. Detailed analysis of construction.

In the case of materials used in the above description, it should be emphasized that they are exemplary (proposed) because it can use other similar physicochemical properties. Instead of latex can be used LKBS 45-50 Plastogen G (Resin German production) or Mercox CL-2R (resin fine-Japanese production). In the case of soft organs pickling in hydrochloric acid can be used interchangeably 40% solution of potassium hydroxide at a temperature of

40° - 50° C. The instruction in the art of corrosion must be maintained as well as the same performance must be accurate and precise. Thus resulting corrosive preparations will be great material for further research (Krucker, Lang, & Meyer 2006)

2. Purpose of work

The purpose of the study was to evaluate the usefulness of this technique in morphological studies as well as trace the history of the formation and modification of anatomical preparations corrosive.

3. Description of knowledge

3.1 The history of anatomical preparations

The first mention of the preparations made by injecting corrosion and gradual etching were already for in turn of the fifteenth and sixteenth century. The creator of the anatomical preparations corrosive this injection technique is considered to Dutch natural scientist and medical John Svammerdam lived between 1637-1680, it was also discovered the red blood cells in 1658 as ovarian germ glands of the lymphatic system and valves in 1664. Early formulations made by corrosion Svammerdam dates back to the year 1672 (Orly, 1998). The table 1 outlines the historical (XVI, XVII and XVIII century first half) of the first formulations corrosion performed by the investigator as well as the used diluent.

Table 1. The first injection material in historical perspective (Orly, 1998).

Author	Date	Injection material
A. Gigliani	XlV	water
L. da Vinci	1504-1507	wax
G. B. da Carpi	1522	hot water
A. Vesale	1543	air
W. F. von Hilden	1615	no data
J. Swammerdam	1672	melted wax
G. Homberg	1699	hot metals (tin)
R. Vieussens	1706	dyes from saffron, water
A. C. Thebesius	1708	water, boring wax
F. Ruysch	1726	"materia ceracea"
Ronhaut	1718	gelatine
G . A. Langguth	1746	no data

Originally it used for the injection of organs commonly available substances and therefore such as water, liquid dyes (colored substances) and sometimes even the air. Injection materials, due to its physical properties were supposed to fill the anatomical structure of the test, show additional details, which apparently were unobservable (Figure 1 and 2).

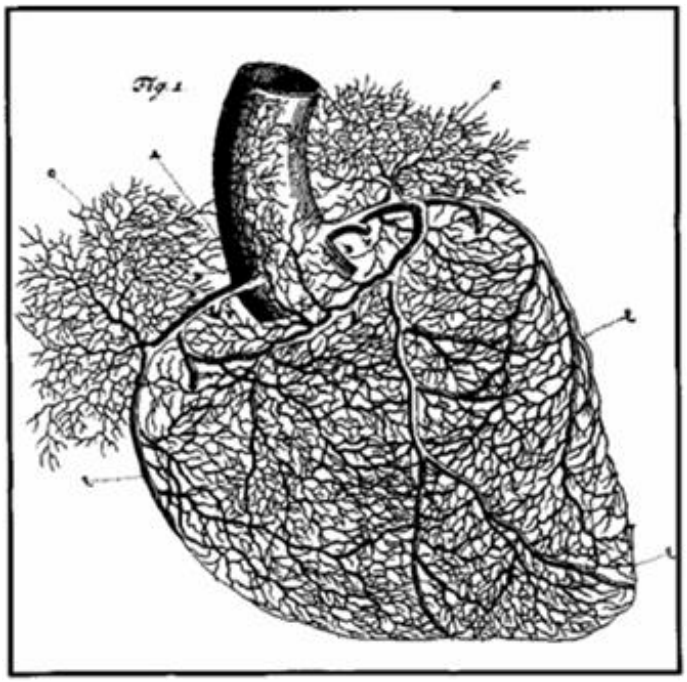

Figure 1. Heart vascular system - the handwritten sketch made by F. Ruysch (1726) (Orly, 1998).

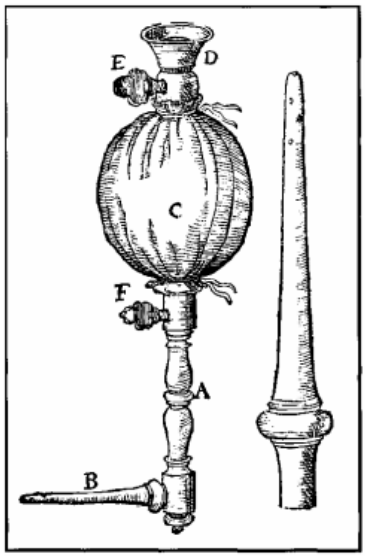

Figure 2. Apparatus for injection formed Hilden von WF (1646); A and B - the combined tubes, bladder C, D - funnel, E and F - the valves. (Orly, 1998).

Mistakes made during the injection of quite often lead to disruption of blood due to pressure exerted on the drive fluid. Therefore thus obtained at that time preparations were mainly transient and sometimes they can not be used for observation. Such materials have been sought that would fill carefully examined organ and after the injection of ulegałyby solidification. One such material becomes molten wax and adhesives and resins, additives pigments. After injection of this weight it is rapidly cured so that it was possible to carry out further corrosion formulation injected placing the organ in a solution of KOH or with concentrated HCl and sometimes used for these purpose larvae of insects which destroy soft tissue. The resulting castings were already permanent spatial images of anatomical structures. Over time, researchers have tested different substances in view of their suitability as filler material for the preparation of anatomical preparations corrosion. In the second half of the eighteenth-century German doctor, physicist and anatomy JN Lieberkuhn used as a filler material mixture of wax, rosin, and turpentine with the addition of dyes. The formulations obtained by using the weight of the injection, however, showed high embrittlement, and therefore to improve the stability immersed in the aqueous suspension of the powdered plaster and brick flour. To dissolve a novel for the times (age XIX) it has the use of suitably prepared glass sealant (Orly, 1998).

The chemical composition of the filling material and the method for injection of the blood and lymphatic vessels developed a Polish doctor anatomist, Calvinist Ludwik Karol Teichmann lived in the years 1823-1895. The basic component of the mass entering the patties was chalk slurries or mixed with zinc white or linseed oil varnish containing pigments. It is worth noting that the injection of blood Teichmann used a syringe of his own design, which was provided with a thread for the punch. When screwing the piston underwent reduction of the force required to force the mass of putty and at the same time prevented that abrupt changes in pressure. Preparations made personally by the Teichmann preserved in very good condition to this day you can see them in the Anatomical Museum of the Jagiellonian University in Krakow (Figure 3) (Gryglewski, 2014). Over time, corrosion technology underwent some modifications as well as the use of new (and better) solutions. In particular, it is connected with the corresponding expected results, the development of the chemical composition of the filler material examined organs. In the twentieth century the use new components of the injection mass, which include methyl methacrylate, polyvinyl chloride, and polyester resins. Due to the specific physico-chemical properties of these substances can be

effectively and accurately visualize and consolidating of very fine anatomic structures in the vascular system, the bile duct or the bronchial tree (Djonov, & Burri, 2004).

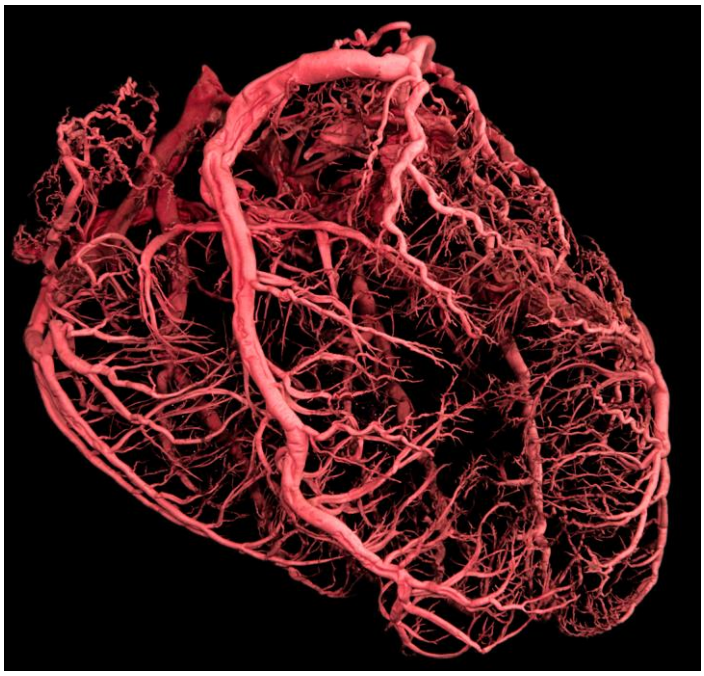

Figure. 3. Angioarchitecture of the human heart (Anatomical Museum of the Jagiellonian University in Krakow, photographed by Grzegorz Wróbel)

3.2 Modern formulations corrosion

Currently, anatomical preparations corrosion by the development of electron microscopy, and especially after the introduction of a scanning electron microscope, have become increasingly important in the preparation of material for the study of organ microvasculature. Today corrosion technique is significant modifications introduced by the researchers, however, the meaning of its application remains the same. The problem of vascular development and organization of the microcirculation within the cancerous tissue, especially solid tumours is the subject of numerous studies. The microcirculation of tumours is essential for the metabolism and specific behaviour of the tumour tissue. When the processes occur in tumour growth, while there is very often necrosis in the central portion thereof. This is due to progressive renal functional and angiogenic tumour vasculature and tumour vascular degeneration. The simultaneous occurrence of both of these processes, typical of a tumour vascular system makes the spatial arrangement of living tissue tumour model reproduces substantially surround the active vasculature. There is no doubt that in the case it is possible to block angiogenesis inhibition of not only the primary tumour but also of metastatic disease (Bampi et al., 2012; Fukumura, Duda, Munn, & Jain, 2010; Nagy, Chang,

Shih, Dvorak, & Dvorak, 2010; Jain, 2005; Miodoński, Bugajski, Litwin, & Piasecki, 1998; Konerding, Miodoński, & Lamatschwandtner, 1995).

Preparation of casting the corrosion vessel in terms of the analysis of vascularization in an SEM image, extends the steps described above, however, except that in addition, a coating of the casting metal (gold or platinum and gold), provides the possibility of an accurate assessment of the organization of the vascular network in various organs at the level of microvessels (Figure 4) (Giuvărăşteanu, 2007).

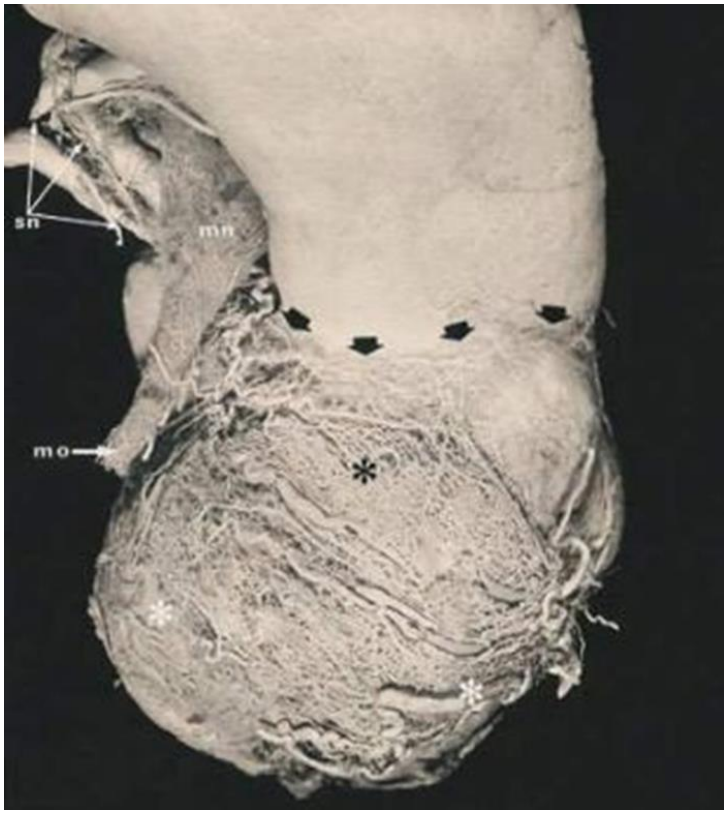

Figure 4. Image from a scanning electron microscope showing the tumour growth at the bottom of the human kidneys. The extent of a tumour conditioned by the presence of vessels that cover a tumour, especially those with a small diameter. The black arrows represent the boundary between the sick and the healthy part of the organ. In the photograph have been marked, the proper vessels of the renal pelvis (mn) and the ureter (mo) and large vessel renal pedicle (sn) (Dulak, 1998).

Animal experiments are seeking solutions in many directions related to tumour angiogenesis, particularly in finding suitable drugs that would effectively inhibit tumour

growth while preventing the cloning of resistant cell clones (Kim, 2009; Mognetti, Di Carlo, & Berta, 2006; Ninomiya, & Inomata, 2006)

4. Conclusions

Anatomical preparations corrosive achieved through the application of corrosion techniques are a valuable source of information about the anatomy of animal organs.

Extensive use of this technique in medicine, veterinary and comparative anatomy of vertebrates underlines its usefulness and the need to use. Test results based on the method of corrosion, above all, allow to know the distribution of blood vessels in the walls of the cavernous organs, it is important in the context of functional and clinical

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