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Application of Duracryl plus for preparation of corrosion casts of venous coronary tree of human heart

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Abstract: Duracryl Plus is a synthetic resin, self-polymerizing copolymer of methyl methacrylate and acrylate, which is widely used in dental practice. The aim of this study was to apply it to fill the venous vascular beds of human hearts to obtain corrosion cast ready to describe wanted parameters of venous coronary vessels.

Key words: Duracryl Plus, coronary sinus, injection study, corrosion casts.

Introduction

Classical injection studies are still useful in researches of normal anatomical and pathologic structures. Throughout centuries anatomists have used hundreds of various substances [1].

Observation of vascular system of different species, including humans is recently carried out using different techniques — both in living and dead bodies. From anatomical point of view however it is still dissection aided by corrosion casting technique which seems to be the leading method of macroscopic investigations. The researches on the vascular system are still commonly carried out on vessels which are filled with different masses — it allows

to join traditional model of anatomical dissection with the clinical requirements i.e. studies on heart blood vessels still focus on the course and blood supply, although there is much attention paid now to the access to different locations using vascular approach. There is still a necessity to investigate special aspects of vascular system i.e. orifice of pulmonary veins into left atrium or sinus venarum of the right atrium. Intervention cardiologists show recently great interest in studies of the venous coronary tree of human heart [2–4].

Corrosion casting method is recently one of the methods used for preparation of the specimens which among others can be studied using scanning electron microscopy [5]. It arose however from gross anatomy. Leonardo da Vinci and Jan Svammerdam used melted wax to make casts of brain ventricles, heart chambers or inject blood vessels. Gottfried Bidloo applied melted metal to fill the bronchial tree. Johannes Lieberkühn invented a mixture of resin and turpentine, injecting next capillaries of the alimentary tract. By the end of the nineteenth century Hyrtl, Teichmann, Hoyer Sr. and Jr., Gerlach, Kadyi followed anatomical researches using different kinds of filling media. In 1952 Taniguchi used for the first time acrylic resin for injection studies — next Aleksandrowicz and Łoziński used polyester resin (1959), Goetzen in 1966 — vinyl chloride, methylmethacrylate — Murakami in 1971, Batson No. 17 — Nopanitaya et al. in 1979, Tardoplast - among others by Lametschwandtner et al. in 1990. After injection of given above substances, all soft tissues were subsequently removed to receive corrosion casts ready for further inspection [6].

Material and methods

Duracryl Plus (SpofaDental, Czech Republic) is a self-polymerizing resin used in prosthodontics to repair mobile prostheses or for construction of immediate prostheses [7]. It is quite resistant to flexion, is produced as color mass, reveals quite long lasting plasticity. For us it seemed to be an excellent medium to fill large venous coronary vessels of human heart.

$$C_5H_8O_2$$
$$CH_2 = C(CH_3)–COO–CH_3$$

- density: 940.00 kg/m³
- molar mass: 100.121 g/mol
- temperature of ebullition: 101°C
- melting temperature: –48°C
- name following IUPAC (International Union of Pure and Applied Chemistry): methyl 2-methylpropenoate

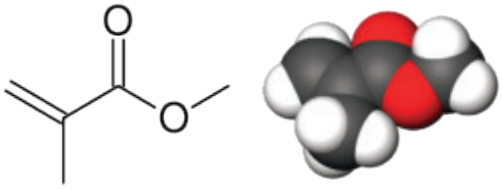

Table 1. Physical and chemical properties of Duracryl Plus.

The studies were carried out on 80 specimens of human hearts, which were obtained from cadavers during autopsies performed in the Department of Forensic Medicine Medical College Jagiellonian University (the research was made in accordance with agreement given by Ethic Committee of Jagiellonian University Medical College — nr KBET/40/B/2007). Entire hearts were washed in running tap water to remove blood and clots from atria and ventricles, next the venous bed of the hearts was rinsed with prewarmed saline (Baxter Terpol, Poland) for 3–5 minutes, through ball-pen needles mounted into orifice of the coronary sinus, to remove remnants of blood from the vascular bed of the heart.

Subsequently the cardiac veins were filled with acrylic mass Duracryl Plus (SpofaDental, Czech Republic), dyed with blue pigment, using a 20 ml syringe, under the pressure generated manually. The mass was injected through the orifice of the coronary sinus into the right atrium. Injection mass was obtained through mixing Duracryl Plus powder (copolymer of methylmathacrylate and methylacrylate) and the Duracryl Plus liquid (methylmethacrylate, dimethylparatoluidine, ethylenglycoldimethacrylate) at 1 : 3 ratio of components. Thus obtained mass had a consistency of a liquid, relatively not very dense, what enabled its penetration of small vessels and also extended the time of condensation suggested by manufacturer. Such procedure allowed to fill the vascular bed completely. Duracryl Plus is a low hydrophilic, self-polymerizing resin, non-soluble in acids, resistant to compaction. It does not change the volume after solidification and this is why it may be used to obtain accurate and durable casts.

For comparative purposes three human hearts were injected with Thixoflex (Zermapol, USA), also dyed with pigment. This material, a fluid condensation silicone, is used in everyday dental practice (to compare it with Duracryl Plus). However despite its short solidification time (around 3 minutes), the casting was difficult and obtained casts were no more precise than these obtained by filling with Duracryl Plus (Fig. 3, 5).

Next the specimens were washed several times in warm running and distilled water. Subsequently, they were placed in 10–15% solution of KOH for maceration. The maceration process last approximately three weeks. A solution of potassium base was renewed every day after rinsing the specimen in distilled water. Then the casts were cleaned of remnants of tissues in a 3% trichloric acid solution. Then they were rinsed again in distilled water. Thus obtained corrosion casts were analyzed.

Results

Duracryl Plus does not penetrate the capillary bed because of the size of particles and relatively high viscosity. Anyway the casts obtained were stable and the method improved significantly readability of the specimens (Fig. 1, 2, 4). Besides, technically Duracryl Plus is easier for application, most evidently thank to relatively long time of hardening — or rather long enough to fill the vascular bed and next observe its solidification. Application of Duracryl Plus enables after its hardening easy measuring of dimensions of tributaries of the coronary sinus as well as evaluation of the angles at which the tributaries join the main vessel. Cast obtained by filling the vascular bed with Thixoflex did not reflect properly the shape of the vessels studies. They were non-naturally smooth and suffered from numerous artifacts caused probably by quick hardening of the mass.

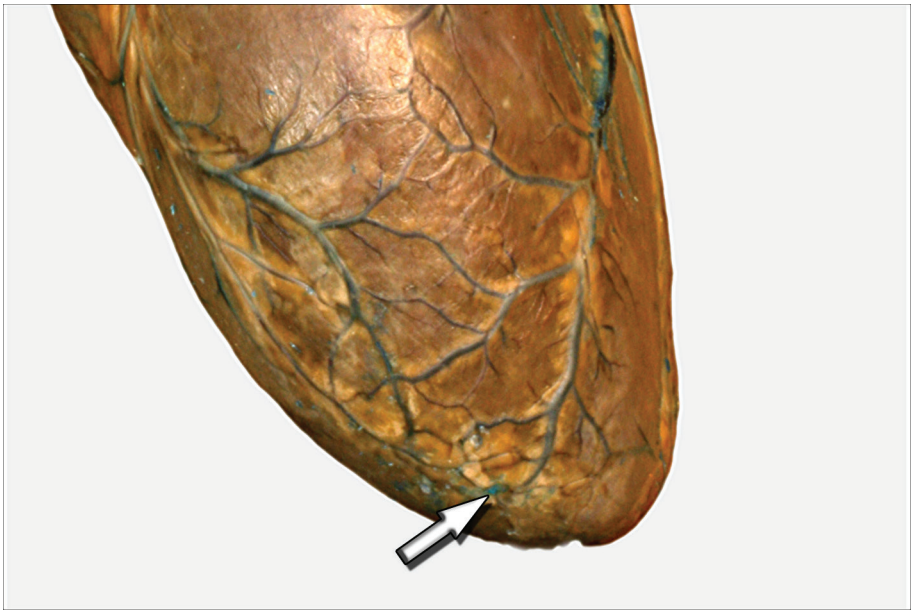

Fig. 1. Human heart. Specimen injected with Duracryl plus. Arrow indicates anastomoses between the great and the middle cardiac veins in the vicinity of heart apex.

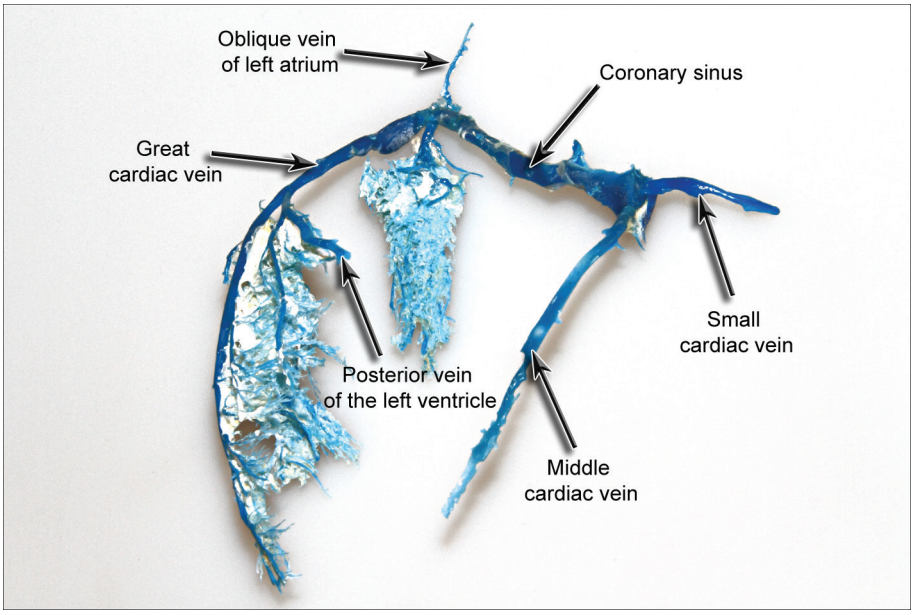

Fig. 2. Coronary sinus and its tributaries injected with Duracryl plus.

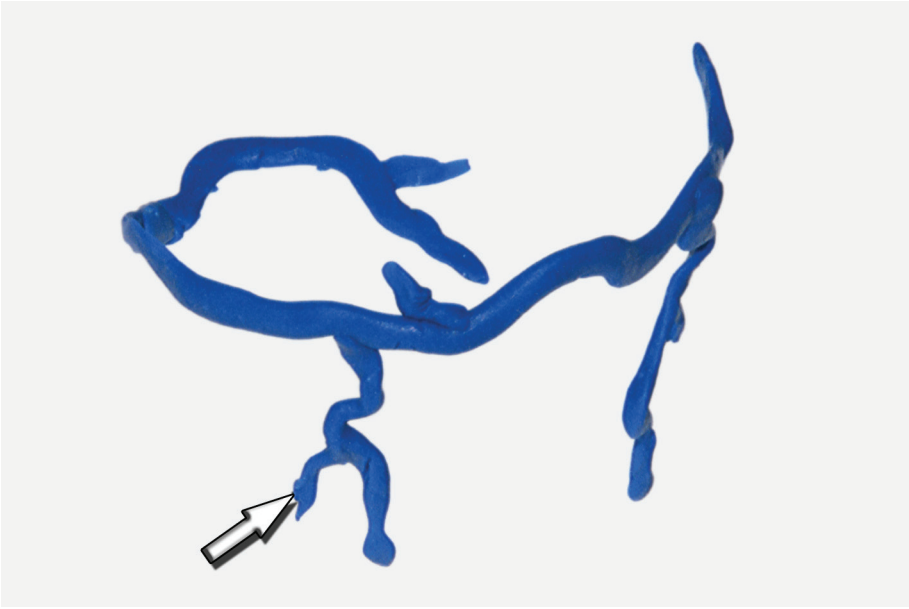

Fig. 3. Posterior vein of the left ventricle (arrow) and its connection with the great cardiac vein. Specimen injected with Thixoflex.

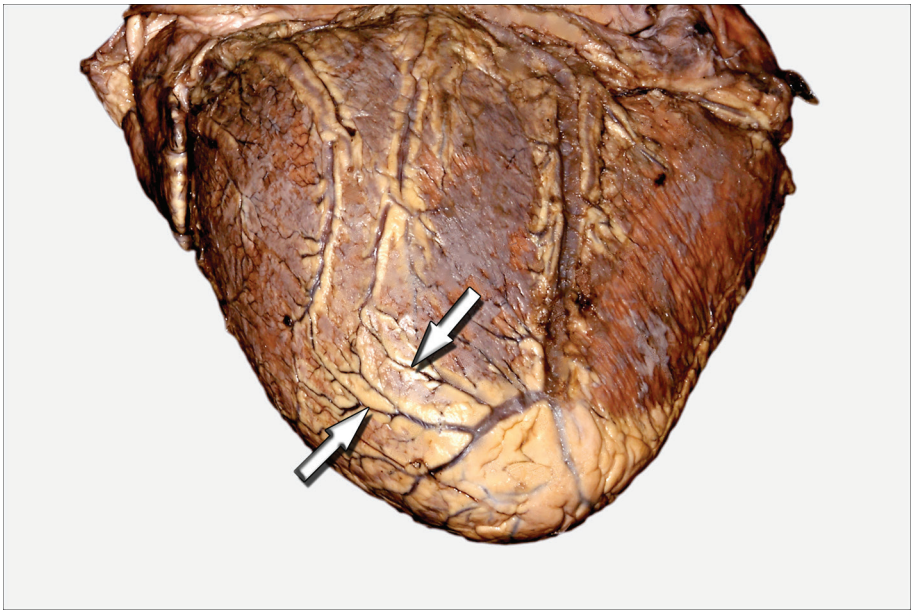

Fig. 4. Venous anastomoses between the posterior vein of the left ventricle and the middle cardiac vein (arrows). The view from behind. Specimen injected with Duracryl plus.

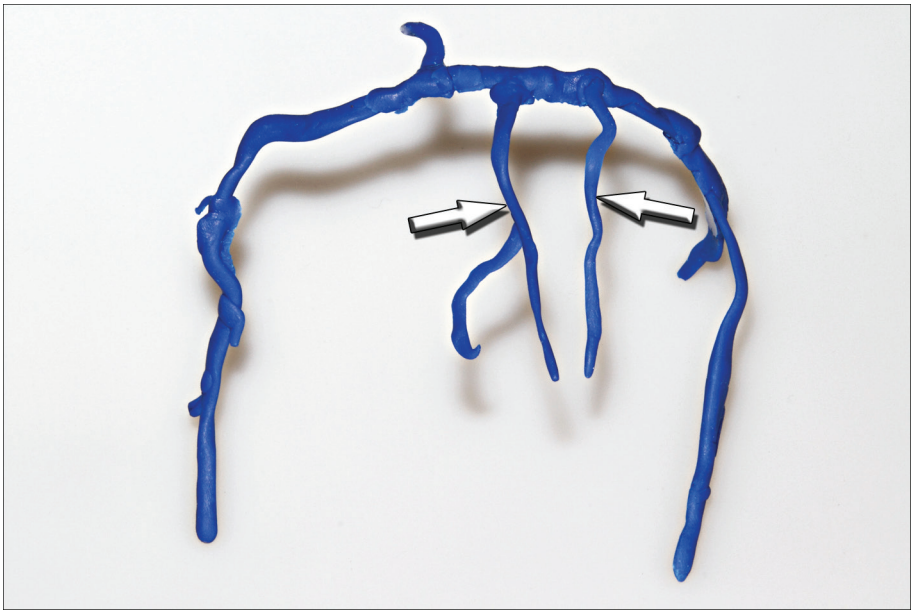

Fig. 5. Double posterior vein of the left ventricle (arrows) — specimen injected with Thixoflex.

Discussion

Area of venous coronary tree is recently of great interest [2, 3, 8, 9]. Human venous coronary tree is one of the most commonly used for medical interventions (i.e. electroablations, coronarographies, etc.) [9–11]. The results of the injection accompanied by corrosion casting method are mostly dependent on the time elapsing between the moment of the death and the time necessary to undertake proper procedures required for preparation of the dissection material for further studies [12]. It is widely known that certain condition, i.e. temperature of environment, cause of death, application of medicines may accelerate process of necrosis, especially considering hardiness of the elements of vascular system. The vessels commonly become permeable, they rupture during filling with injection masses, becoming useless. However it was proved on many examples that such studies should be carried out despite possible artifacts seen macroscopically [5, 13]. Several known studies were performed using Liquitex R or other substances [14–17].

Conclusions

Although Duracryl Plus is mostly used for repair of dental prostheses it can be easily applied to create relatively precise casts of human venous coronary tree, as shown on the photographs (Fig. 1, 2, 4). Thus obtained specimens are valuable for macroscopic inspection — they allow measuring of caliber and dimensions of coronary venous tree tributaries in most of cases.

The filling medium used in our study did not interfere with the endothelium of the vascular wall. Chemical and physical properties of the mass cause that it is highly recommended to receive three-dimensional casts of the vascular tree, especially when one wishes to get specimens which do not change the volume and other parameters (i.e. angle of origin, etc.).

References

1. *Cole F.J.*: The history of anatomical injections. In: Singer C (ed.). Studies in the history and methods of science. Oxford University Press, London 1921, pp. 285–343.
2. *Hołda M.K., Klimek-Piotrowska W., Koziej M., Mazur M.*: Anatomical variations of the coronary sinus valve (Thebesian valve): implications for electrocardiological procedures. Europace. 2015; 17 (6): 921–927.
3. *Hołda M.K., Koziej M., Klimek-Piotrowska W.*: Thebesian valve: the cause of unsuccessful retrograde coronary sinus cannulation. Anatol J Cardiol. 2015; 1, 15 (3): E8–9.
4. *Koźluk E., Gaj S., Kiliszek M., Łodziński P., Piątkowska A., Opolski G.*: Efficacy of catheter ablation in patients with an electrical storm. Kardiol Pol. 2011; 69 (7): 665–670.
5. *Bereza T., Tomaszewski K., Skrzat J., Klimek-Piotrowska W., Sporek M., Mizia E., Lis G., Pasternak A.*: Quality of corrosion specimens prepared from material obtained during autopsies — a preliminary study. Folia Med Cracov. 2013; 1: 5–12.
6. *Miodoński A.J., Kuś J.*: Metody iniekcyjne w badaniach układu krwionośnego. Wszechświat. 1978; 7–8: 183–186.
7. *Tubbs R.S., Hansasuta A., Loukas M., Louis R.G. Jr., Shoja M.M., Salter E.G., Oakes W.J.*: The basilar venous plexus. Clin Anat. 2007; 20 (7): 755–759.
8. *Duda B., Grzybiak M.*: Main tributaries of the coronary sinus in the adult human heart. Folia Morphol (Warsz). 1998; 57 (4): 363–369.
9. *Ogawa K., Hishitani T., Hoshino K.*: Absence of the coronary sinus with coronary venous drainage into the main pulmonary artery. Cardiol Young. 2013; 23 (5): 759–762.
10. *Duda B., Grzybiak M.*: Variability of valve configuration in the lumen of the coronary sinus in the adult human hearts. Folia Morphol (Warsz). 2000; 59 (3): 207–291.
11. *Grzybiak M.*: Morphology of the coronary sinus and contemporary cardiac electrophysiology. Folia Morphol (Warsz). 1996; 55 (4): 272–273.
12. *Martin-Orti R., Stefanov M., Gaspar I., Marin R., Martin-Algualcil N.*: Effect of anticoagulation and lavage prior to casting of postmortem material with Mercox and Batson 17. J Miscrosc. 1999; 195: 150–160.
13. *Lametschwandtner A., Lametschwandtner U., Weiger T.*: Scanning electron microscopy of vascular corrosion casts — technigue and application: updated review. Scanning Microsc. 1990; 4: 889–941.
14. *Pityński K., Skawina A., Lipczyński W., Polakiewicz J., Walocha J.*: The posterior gastric and superior polar arteries in human fetuses. Folia Morphol. 1996; 55 (1): 43–49.
15. *Pityński K., Skawina A., Polakiewicz J., Walocha J.*: Extraorganic vascular system of adrenal glands in human fetuses. Annals of Anatomy. 1998; 180: 361–368.
16. *Vitalariu A.M., Lazăr L., Buruiană T., Diaconu D., Tatarciuc M.S.*: Surface characteristics of the acrylic resins according to the polishing methods. Rev Med Chir Soc Med Nat Iasi. 2011: 115 (2): 542–547.
17. *Walocha J.A., Miodoński A.J., Gorczyca J., Skrzat J., Bereza T., Ceranowicz P., Lorkowski J., Stachura J.*: Application of acrylic emulsion Liquitex R (Binney and Smith) for the preparation of injection specimens and immunohistochemical studies — an observation. Folia Morphol. 2003; 62 (2), 157–161.