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Morphometric Characteristics of Renal Vessels and Ureter Concerned on Mulages Obtained by Plastic Injections

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Abstract: *The study was performed on a number of 48 plastic molds, obtained by injection of Technovit 7143. Technovite is a self-curing resin based on methyl methacrylate. Technovite no longer requires the use of dyes that can adversely affect the polymerization process and has a short polymerization time, making corrosion possible shortly after injection.*

Keywords: *renal vessels-ureter-morphometry-plastic molds*

1.Introduction

This paper aims to highlight the role of Technovit 7143 in obtaining anatomical molds, which allow the evaluation of morphometry and anatomical variations. It is a relatively new method, and extremely rarely used in Romania but which can be easily applied to other university centers. We consider it an easy method to apply and with very good research results. It was mainly used TECHNOVIT 7143, which is not a toxic substance, is easy and fast to prepare and no longer requires the use of dyes that can negatively influence the polymerization process. In addition, it has a short polymerization time, being able to control it depending on the amount of solvent, which makes possible the corrosion at a short interval after injection, no longer requires a time interval of 1-2 days for corrosion, as when using ordinary plastics [1-3].

Visceral branches of the abdominal aorta and mainly intended for the kidneys, the renal arteries play a dual role: nutritional and functional. The renal arteries are the main arteries of the blood purification, representing at the same time the nutritional arteries of the kidneys and their fat capsule, the calyxes, the basins and the upper part of the ureters. They take part in the vascularization of the adrenal glands and lymph-aortic lymph nodes. It strikes the disproportion between the relatively small volume of the kidney and the considerable diameter of the arterial trunk. This disproportion is even more evident when comparing the diameter of the hepatic artery destined for the enormous hepatic gland with that of the renal artery destined for a ten times smaller organ.

2.Material and methods

Purpose of the work: Determination of the diameters of the trunks of the renal arteries at the origin and their termination, as well as of their collateral and terminal branches, comparing them right / left, the comparison being made with the dimensions of the venous vessels and the corresponding ureters.

Our study was performed on a number of 48 plastic molds obtained by injections of German-made Technovit 7143, a self-curing resin based on methyl methacrylate in powder and liquid form. For the preparation of the injectable substance we used two parts of powder and one part of liquid, the plastic mass injection being performed on fresh organs, represented by single kidneys (the injection being done on the renal vessels and on the ureter) or on organic blocks represented by the two kidneys with the renal pedicles, together with the portions of the abdominal aorta and the corresponding inferior vena cava,

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injecting the plastic mass into the aorta, inferior vena cava and ureter. The powder was red for the arteries, blue for the veins and yellow for the urinary system. After injection and solidification of the injected substance, the resulting anatomical parts were corroded with NaOH and photographed. The measurements were performed with the data controller, the number of cases on which the statistics were made being characteristic for each item tracked. The determinations were not made by sex. Our results were compared with the existing data in the existing anatomical literature. The study was conducted within the anatomy department of the Faculty of Medicine from Constanta.

For injection I used mainly TECHNOVIT 7143, made in Germany. Technovite is not a toxic substance, it is prepared very easily and quickly, and due to the fact that the monomer is colored, it no longer requires the use of dyes that can negatively influence the polymerization process. In addition, it has a short polymerization time, being able to control it according to the amount of solvent, making possible the corrosion at a short interval after injection, no longer requiring a time interval of 1-2 days for corrosion, as in the case of use ordinary plastics. The various cumbersome and laborious processes for the preparation of injectable plastics were thus removed, in the case of technovite only the problem of the ratio between solvent and solvent arose, depending on the period of time in which I wanted to carry out the polymerization and therefore corrosion. In the case of using too dilute products, molds were obtained with many thin vascular branches that prevent good visualization of the main vascular trunks.

Immediately after injection, the instruments used for this should be washed with diluent solutions to avoid polymerization of the remaining substance in the containers used for the preparation of the substance: syringes, catheter or other instruments used in the injection process.

Molds obtained by technovit injection are not as brittle as those obtained by injection of polyvinyl chloride or polyester oils, being more elastic and resistant. The injection of the plastic was preceded by the injection of water into the renal vessels to remove any blood clots, which could compromise the production of good quality molds and to ligate any broken vascular collaterals. The water was then removed by blowing air and lightly compressing the kidneys.

Technovite is a self-curing resin based on methyl methacrylate in powder and liquid form, the powder being of five colors: red, yellow, blue, green and orange. The fluidity and its mixture depend on the proportions of the mixture of the two components, the solidification of the preparation being done in 6-15 min. Technovite is soluble in chlorinated hydrocarbons, esters and ketones. Two parts of powder and one part of liquid are used to prepare the injectable substance, but the proportions of the mixture vary depending on the consistency we want to obtain. It is recommended to use glass, porcelain, polyethylene or metal containers to prepare the mixture. First put the liquid in the container and then add the powder, in the proportions we want. Wooden spatulas, metal spatulas (preferably stainless metal), porcelain or polyethylene can be used for mixing. The heat accelerates the solidification, and the low temperature slows it down. The preparation of the mixture must be carried out continuously, without interruption. There must be no source of fire during the preparation of the mixture, as the liquid is flammable.

3.Results and discussions

The origin of the right renal artery in the aorta, followed by a number of 26 cases (organic blocks), i found it above-situated than the origin of the left renal artery in 16 cases (61.53% of cases), with differences of 5 , 5-7.2 mm); in 6 cases (23.08% of cases) the origin of the left renal artery was above-mentioned, with differences between 6.1-7.1 mm; in 4 cases (15.38% of cases) the two renal arteries, right and left, had their origin from the aorta located at the same level, (Figure 1, 2, Table 1).

In classical literature, without indicating the difference and percentages, for [4-8] the two renal arteries have their origin located at the same level, for [9, 10] the left renal artery has its origin above, only for [11,12] the right renal artery having the origin of the aorta above located against the origin of the left renal artery**.** Ecoiffier finds the highest percentage in cases where the renal arteries have their origin located at the same level and in a percentage only by 2.04% lower in which the right renal artery has its origin above [13]. Our results are close to the results of [11] in the case of the origin of the right

renal artery above and 7.78% higher than the results of [14] in cases where the left renal artery has its origin above. In the other cases, our results are lower than the literature data.

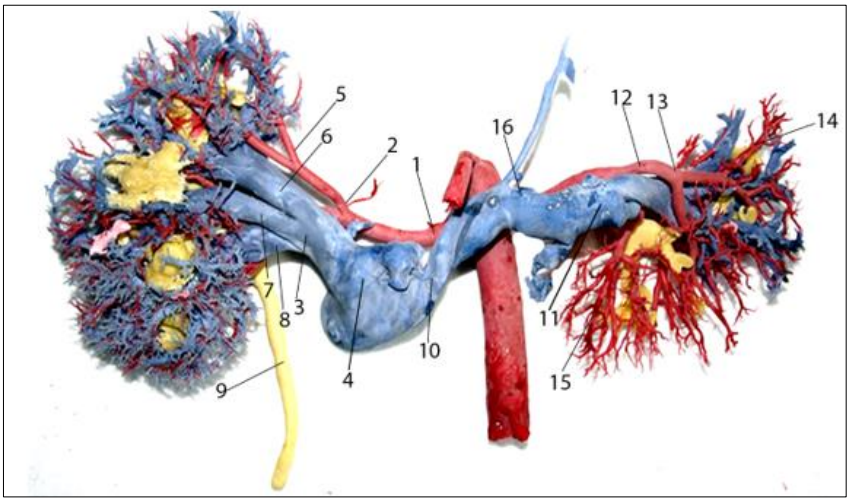

Figure 1. Front view. 1.Diameter at the origin of the right renal artery: 5 mm; 2. diameter at the level of the terminal branch of the right renal artery: 3.2 mm; diameter at anastomosis of anterior venous branches: 13 mm; 4 diameter at the end of the right renal vein: 14 mm; 5. diameter of the right upper polar artery: 3.2 mm; 6. diameter of the antero-superior right venous branch: 7 mm; 7. the diameter of the anterior middle straight venous branch: 4.8 mm; 8. diameter of anterior right inferior venous branch: 6.1 mm; 9. diameter of the right ureter: 4.9 mm; 10. diameter at the end of the left renal vein: 13 mm; 11. diameter at left renal vein formation: 11.5 mm; 12. diameter at the level of branching of the left renal artery: 5.2 mm; 13. diameter of left anterior branch: 4 mm; 14. diameter of left upper polar: 3.1 mm; 15. diameter of left lower polar: 3.0 mm;
16. diameter of left renal vein at formation: 12.4 mm.

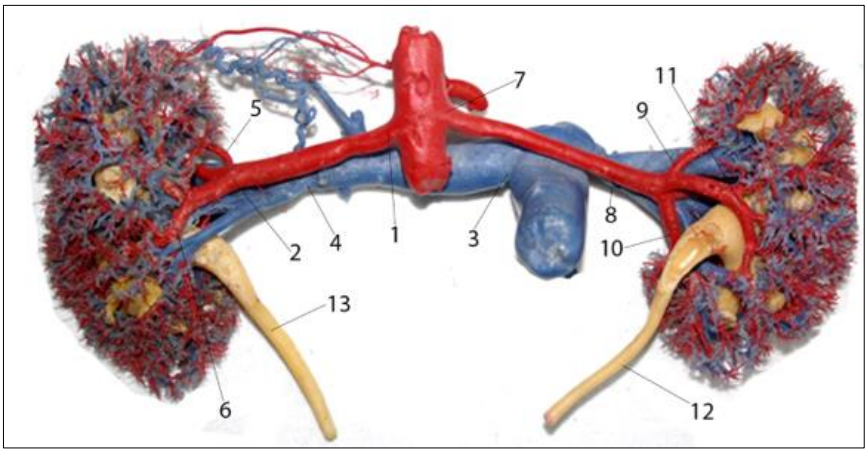

Figure 2. Rear view. 1. Diameter at the origin of the right renal artery: 7.1 mm; 2. diameter at the level of the terminal branch of the right renal artery 6.8 mm; 3. diameter at right ventricular vein formation: 13 mm; 4 diameter at the end of the right renal vein: 14.5 mm; 5. diameter of the right upper polar artery: 5.3 mm; 6. diameter of the right ureter; 5,5mm; 9. Left upper polar diameter: 5.32 mm; 10. diameter of left renal artery at origin: 5.5 mm; 8. diameter of left renal artery at endpoint: 6.7 mm; 9. diameter of the right ureter: 4.9 mm; 10. diameter of left lower polar: 5.3 mm; 11. diameter of the posterior branch of the left renal artery: 6.2 mm; 12. diameter of the left ureter: 5.5 mm;
13. diameter of the right ureter: 6.4 mm

Table 1. Level of origin of aorta of renal arteries

The author	Right above	Left higher	Same level
Coves	65%	-	-
Delas V	34.69%	28.57%	36.73%
Ecoiffier	20.5	7.6%	71.8%
Ternon	20.1%	45.5%	34.4%
Present results	61.53%	15.38%	23.08%

At the origin of the aorta, in a number of 46 cases, the right renal artery had a diameter between 5.5 - 7.2 mm, the average diameter being 6.44 mm.

At the level of its terminal branch, this artery had a diameter between 4.5-6.6 mm, the average diameter being 5.71 mm.

The left renal artery, on a number of 44 cases, was present at its origin from the aorta with a diameter between 6.1-7.1 mm, the average diameter being 6.69 mm, at the level of its terminal branch the diameter of this artery being between 5.0-6.1 mm, the average diameter being 5.67 mm, (Table 2).

Table 2. The diameter of the renal arteries at the level of their origin in the aorta

Author	The diameter of the renal artery
Papin	8 mm
Testut	5-7 mm
Cover	7 mm
Merklin & Michels	6-8 mm
Luschka	8 mm
Ternon	4-6.5 mm
Schmerber	6-7 mm male 5-6 mm female
Juskiewenski	4-6 mm
Delmas V	male right = 7.7-10 mm; left = 8.7-12 mm female right= 5.8-8.5 mm; left = 5-7,8 mm
Present results	right 5.5-7.2 mm left 6.1-7.1 mm

The maximum diameter of the renal artery is given by [15], a value that we have not encountered in any case, and [13] has met only in the left renal artery and only in the female sex; and the minimum diameter is given by [9,13].

Our results are similar to his [4,5] results in the right renal artery and Schmerber's results [13] in the left renal artery.

Comparing the right / left kidney artery diameters in their origin of the aorta with a number of 24 molds, we found that in 3 cases (12.50%) the right renal artery had a larger diameter with differences between 0.1-0.5 mm. in 12 cases (50%) the left renal artery was larger than the right one with differences between 0.1-1.0 mm, and in 9 cases (37.5%) the two renal arteries, right and left, had the same diameter.

At the level of the terminal branch, in a number of 24 cases, the right renal artery had a larger diameter in 9 cases (37.5%) with differences between 0.1-1.1 mm; also in 9 cases (37.5%) the left renal artery had a larger diameter with differences between 0.6-1.05 mm, and in 6 cases (25%), the two arteries had the same diameter.

The diameter of the anterior terminal branch of the right renal artery, on a number of 38 cases, we found between 4.0-10.5 mm, the average being 5.45 mm, the diameter of the posterior terminal branch of the same artery being between 3.9-10.0 mm, the average being 5.18 mm.

The diameter of the posterior terminal branch of the left renal artery, in a number of 36 cases, we found between 3.1-8.0 mm, the average being 5.04 mm, the diameter of the posterior terminal branch of the same artery being between 3.1-8.2 mm, the average being 5.3 mm.

Comparing the diameters of the anterior branches with the posterior ones of the right renal arteries, on a number of 32 cases, we found that in 19 cases (59.37%) the right anterior branch had a larger diameter with differences between 0.1-2.5 mm; in 10 cases (31.25%) the right posterior branch was

larger, with differences between 0.3-1.0 mm, and in 3 cases (9.38%) the two branches had the same diameter .

Comparing the diameters of the anterior branches with the posterior ones of the left renal arteries, in a number of 30 cases, we found that in 16 cases (53.33%) the right anterior branch had a larger diameter with differences between 0.2-2.0 mm; in 7 cases (23.33%) the posterior branch was larger, with differences between 0.3-1.0 mm, and also in 7 cases (23.33%) the anterior and posterior branches had the same diameter.

The right superior polar arteries, on a number of 34 cases, had a diameter between 2.2-4.5 mm, the average diameter being 3.3 mm, and the upper polar arteries on the left, on a number of 32 cases, they had a diameter between 2.2-5.5 mm, the average diameter being 3.90 mm.

The right lower polar arteries on a number of 32 cases, had a diameter between 3.0-4.5 mm, the average diameter was 3.39 mm, and the left lower polar arteries on a number of 30 cases had a diameter between 2.2-4.2 mm, the average diameter being 3.46 mm.

Comparing the diameter of the right and left upper polar arteries, on a number of 26 cases, we found that in 17 cases (65.38%) were larger than the right upper polar, and in 9 cases (34.62%) were more voluminous upper left polar. In the case of the inferior polar arteries, in a number of 24 cases, in 16 cases (66.67%) the upper right poles were larger, with differences between 0.2-1.8 mm, and in 8 cases (33.33%) were larger left upper polar arteries, with differences between 01-0.9 mm.

In a number of 28 cases, we compared the upper and lower right polar diameters, finding that in 16 cases (57.14%) the diameter of the lower polar artery was larger, with differences between 0.1-1.3 mm, in 6 cases (21.43%) the diameter of the upper right polar artery was larger, with differences of 0.1-0.7 mm and also in 6 cases (21.43%) the two arteries had the same diameter .

In a number of 22 cases we compared the upper and lower left polar diameters, finding that in 17 cases (77.27%) the diameter of the lower polar artery was larger, with differences between 0.2-1.8 mm, and in 5 cases (27.73%) the diameter of the upper left polar artery was larger, with differences between 0.2-0.8 mm.

The right renal vein at its end in the inferior vena cava, on a number of 28 cases, we found a diameter between 6.8-14.5 mm, the average being 10.76 mm, and the left renal vein, on a number of 26 cases, present at its end in the inferior vena cava a diameter between 8.0-13.5 mm, the average being 9.54 mm, Table 3.

Table 3. Diameter of renal veins at termination

The author	diameter / mm
Delmas	Right 8-18 Left 8.1-17.1
Le Floch Prigent	10-14
Present results	Right 6.8-14,5 Left 8-13.5

Our results are lower, especially at the level of maximum values, compared to Delmas [13] and higher at the level of minimum values compared to Le Floch-Prigent and Juskiewenski [16, 17].

Comparing the diameter of the right renal vein at the end of the inferior vena cava, with the diameter of the right renal artery at its origin in the aorta on a number of 26 cases, we found that in 25 cases the vein had a larger diameter in 25 cases (96.15 %), with differences between 0.13-7.4 mm, the average of the differences being 4.33 mm. In one case (3.85%) the right renal artery was larger than the diameter of the vein by 0.2 mm.

On the left side, out of 24 cases, the vein had a larger diameter in 23 cases (95.83%), with differences between 2.0-5.3 mm, the average of the differences being 3.5 mm. In one case (4.27%) the right renal artery was larger than the diameter of the vein by 0.18 mm.

The right uterus, on 38 cases, originally had a diameter between 3.5-6.2 mm, the average being 5.32 mm, and the left ureter, on 36 cases, had a diameter between 4.8- 7.0 mm, the average being 5.50 mm, Table 4.

Our results are lower than his results [18,19], both at the level of the minimum value and at the level of the maximum value and are higher at the level of the maximum values compared to [6,12,17,19-21].

Table 4. The diameter of the ureters at origin

The author	diameter / mm
Rouvière	3-5
Juskiewenski	4
Kamina	3-5
Gray	3
Papilian	5-10
Albu	3-5
Ulmeanu	3-5
Present results	Right 3,5-6,2 Left 4.8-7.0

Comparing the diameter of the right renal artery at the origin of the aorta with the diameter at the origin of the right ureter, on a number of 24 cases, we found that the right renal artery had a larger diameter in 18 cases (75%), with differences between 0, 1-3.7 mm, in 6 cases (25%) the right ureter is larger with differences between 0.1-1.2 mm. On the left side, in 16 cases (76.16%), the renal artery had a larger diameter, with differences between 0.2-6.5 mm, in 6 cases (25%) the right ureter was larger with differences between 0.2-1.0 mm [22-24].

Our paper presents as a novelty the fact that it is for the first time, at least in the Romanian anatomical literature, when the morphometry of the artery is presented, and the renal vein and the ureteral morphometry, the measurements being made on plastic molds, up to tenths of a millimeter.

The measurements were performed bilaterally, right / left, while the differences existing between the two parts of the body were established and it is very impoirtant for medical and therapeutic purposes [25]. In the literature, there are no reported right / left volumetric differences, or if mentioned, no morphometric indication is indicated.

The values of vascular diameters at origin, (in the case of arteries) or termination (in the case of veins) or at the level of formation (in the case of veins) or of the terminal branch (in the case of the arteries) are not specified.

The diameters of the renal arteries at their origin in the aorta are not compared with the diameters of the renal veins at their end in the inferior vena cava, nor is the ratio between the diameters of the renal arteries at origin and the diameters at the origin of the corresponding ureters.

The Tehnovit 7143 has been used in our university and other anatomical studies, each time with excellent results [26,27].

4.Conclusions

Most commonly, between the morphometry of the anatomical elements followed (artery, vein, ureter) there are differences in the value of the diameter of the two parts of the body (right and left), less often these elements having equal dimensions, the superior ones are greatly modified in cases where numerical variants of these elements, especially in the renal arteries, which can frequently be multiple, double or triple.

The percentage differences between the authors are due to the number of cases worked, as well as to the working method used, there being valuable differences between the results obtained by dissection, intravascular injections of different substances, or imaging methods: ultrasound, MRI or computed tomography, especially in appreciating the values of the diameters.

The assessment of the values of the diameters of the renal vessels, of their origin and termination is important in establishing the renal segmentation in order to perform the renal segmental nephrectomies

and the kidney transplantation, knowing the ureteral morphometry having importance for the ureteral catheterization, either for exploratory (diagnostic) or therapeutic purpose.

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