

Morphological Variations of Inferior Segmental Artery of the Single Renal Artery

Study on corrosion casts

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In accordance with Terminologia Anatomica, the renal artery gives rise of two branches: anterior branch and posterior branch. Anterior branch gives rise to four segmental arteries: superior, anterior-superior, anterior-inferior and inferior; posterior branch continues with posterior segmental artery. On a total of 150 renal corrosion casts was examined the artery of inferior segment. Three morphological types have been highlighted: Type I, in which the inferior segmental artery originating directly in the trunk of the renal artery (8.0% of cases); Type II, in which the inferior segmental artery arises from the anterior branch of the renal artery (87.33% of cases); Type III, in which the inferior segmental artery arises from the posterior branch of the renal artery (4.67% of cases). In 33.33% of cases the inferior segmental artery arises independently from the trunk or renal artery branches (anterior or posterior). In 66.67% of cases, the inferior segmental artery realizes a common trunk with one or two other segmental arteries (in type II). Knowledge of these aspects is important both to investigate morphological imaging and performing partial resection of the renal parenchyma.

Keywords: kidney; corrosion casts; inferior segmental artery; variations

Spatial distribution of the abdominal aortic branches typologies, are well determined in modal morphologies [1-3]. However, a large percentage undergoes morphological variability, which is most commonly explained by changes in ontogenetic evolution from the first weeks of intrauterine life [1-8]. Morphological variations of abdominal aortic branches are usually classified into: variations of origin [1, 4-8], variations in number [2, 3, 9] variations of trajectory [2, 9] and variations of distribution [10, 11].

For the renal artery, the most common variations are those of number [2, 3, 9-11] with the presence of multiple renal arteries (accessory or additional). The intra-parenchymatous distribution of the renal artery branches has segmental distribution, the number of renal arteries segments being the subject of little morphological variation. The appearance of variability at this level is represented by the different origin (from the trunk artery or its branches - anterior and posterior) of the segmental arteries [11-15]. This aspect is very important for the successful of minimally invasive surgery on renal parenchyma.

In accordance with Terminologia Anatomica [16], the renal artery gives rise to two branches: anterior and posterior branches. Anterior branch gives rise to four segmental arteries: superior, anterior-superior, anterior-inferior and inferior; the posterior branch gives rise to the

posterior segmental artery. In the present study, we analyzed the morphological variability of inferior segmental artery origin and association in case of the single renal artery presence.

Experimental part

In the present study, one used 150 human renal corrosion casts achieved in the Department of Anatomy of the "Victor Babes" University of Medicine and Pharmacy, Timisoara. The corrosion pieces were prepared in the period 2000-2012. Renal pieces were harvested from human cadavers who had no history of renal disease. Injection of the renal vasculo-ductal systems was performed with Ago II plastic compound (product based on nitrocellulose E950), using the technique described by Nanu, Corondan and Bejan [17]. The corrosion of the renal parenchyma was performed with technical hydrochloric acid. All procedures for harvesting the renal pieces and making of corrosion casts were approved by the Ethics Committee of the "Victor Babes" University of Medicine and Pharmacy, Timisoara. Of the 167 pieces of corrosion casts with a single renal artery, were kept only 150 pieces of corrosion casts, who presented the segmentation of the renal parenchyma in accordance with the renal segmentation approved by Terminologia Anatomica [16]. Among the category of the excluded cases was the case in which the lower renal parenchyma was vascularized from two distinct sources

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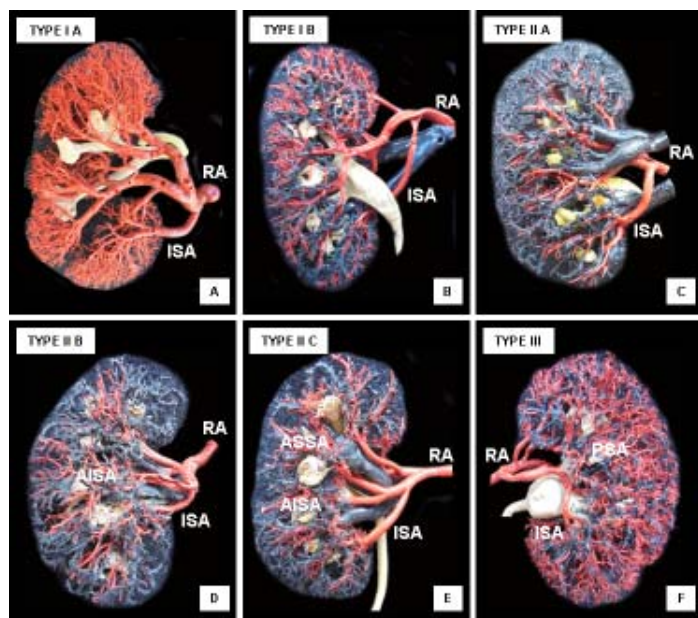


Fig.1. Renal corrosion casts highlighting the morphological types of the inferior segmental artery origin. A, C-E - anterior view; B, F - posterior view. RA - renal artery; ISA - inferior segmental artery; AISA - anterior-inferior segmental artery; ASSA - anterior-superior segmental artery; PSA - posterior segmental artery. [Color figure can be viewed in the online issue, which is available at www.revmaterialeplastice.ro]

(anterior branch and posterior branch of the renal artery). The studied renal vasculo-ductal corrosion casts were photographed (Nikon D3, Tokyo, Japan, AF-S Nikkor Lens f/1.4G) and classified according to the present type of major arterial anatomic variation.

Results and discussions

Depending on the origin of the inferior segmental artery, the studied material represented by the 150 pieces of corrosion casts, were classified into three morphological types:

Type I, in which the inferior segmental artery originating directly in the trunk of the renal artery (12/150 cases - 8.0% of cases), with two subtypes: (ia) in which the inferior segmental artery is the first branch that arises from the trunk of the renal artery (8/150 cases - 5.33% of cases); (ib) in which the inferior segmental artery arises at the same level with other branches of the renal artery (4/140 cases - 2.67% of cases).

Type II, in which the inferior segmental artery arises from the anterior branch of the renal artery (131/150 cases - 87.33% of cases), with three subtypes: (ii) the inferior segmental artery, originated independently from anterior branch (31/150 cases - 20.67% of cases); (IIB) the inferior segmental artery originated from a origin common with anterior-inferior segmental artery (77/150 cases - 51.33% of cases, and (IIC) the inferior segmental artery originated from a common trunk with anterior-inferior and anterior-superior segmental arteries (23/150 cases - 15.33% of cases).

Type III, in which the inferior segmental artery arises from the posterior branch of the renal artery (7/150 cases - 4.67% of cases).

In 33.33% of the cases, the inferior segmental artery originates independently from the trunk or branches of renal artery (anterior or posterior). In 66.67% of the cases, the inferior segmental artery arises from a common trunk with one or two other segmental arteries (in type II).

The terminal character renal artery was first stated by Bertin in 1744 and subsequently confirmed by Hyrtl (1870), which described two territories of renal artery (anterior and posterior) [10, 18]. In a comprehensive study of the renal parenchyma segmentation, Niculescu et al. (1997) [18] presents the kidney segmentation described by: Hyrtl (1970), Gregoire (1920), Graves (1954), Sohler (1954), Gouaze (1955), Löhren (1957), Simionescu (1958), Ternon (1959), Cordier (1964), Sykes (1964), Dos Santos Ferreira

(1967). Of all, the descriptions of Graves of 1954 [19] was accepted at the International Anatomical Congress at Wiesbaden in 1965 and included in *Nomina Anatomica* [20] and in *Terminologia Anatomica* [16].

Of the 167 pieces of corrosion casts originally taken in the study, 17 pieces were removed, in which the inferior renal segment was vascularized from two distinct sources -anterior branch and posterior branch of the renal artery-, i.e. in 10.18% of cases. A higher percentage of corrosion casts with double arterial vascularization (anterior and posterior) of the renal poles (superior and inferior - 18% of cases) has been reported by Zahoi et al. [14].

In morphological literature, there are few studies which analyze clearly the inferior segmental artery origin [21-24]. On the studied material (150 kidney corrosion casts), the inferior segmental artery arises directly from the renal artery trunk in 8.0% of cases, from the anterior branch in 87.33% of cases, and from posterior branch in 4.67% of cases.

The inferior segmental artery arises most commonly from the anterior branch of the renal artery (Type II), the incidence being 87.33% of the cases, among the 150 corrosion casts from the present study. Verma [23] study reported same segmental artery in 88% of cases, Kfer [22] reported in 74%, Chandragirish et al. [24] reported in 59% of cases, and Servo [21] in 47% of cases. The inferior segmental artery arises from the renal artery trunk (Type I) in 8% of cases, in the present study. Chandragirish et al. [24] reported the origin of this artery from the renal artery trunk in 28% of cases, Verma [23] reported in 3.06% of cases, and Kfer [21] in 1.85% of cases. The inferior segmental artery arises from the posterior branch of the renal artery (Type III) in 4.67% of cases, in the present study.

The study of anatomical structures by classical method of dissection allows three-dimensional structures, but cannot be maintained for a long period of time without change the dimensional spatial interrelationships [25]. Using the plastinated cross sections technique, two-dimensional images are obtained, who rebuilt three-dimensional structures by computer. These three-dimensional images can be successfully used in training students and residents in medicine [26, 27]. Preparing corrosion casts by injecting vascular-ductal systems generates three-dimensional models, which can be used for extended periods of time [28, 29], without losing the fidelity of the model.

Conclusions

The injection of renal vascular-ductal systems with plastic materials followed by corrosion of the renal parenchyma leads to corrosion casts perfectly reproducing the three-dimensional spatial distribution of anatomical vasculo-ductal elements. This study showed the origin of the inferior segmental artery origin at three distinct levels: renal artery trunk, anterior branch and posterior branch. Most commonly, the inferior segmental artery arises from the anterior branch of the renal artery (87.33%), with three subtypes: arising independently from the anterior branch, from a common trunk with anterior-inferior segmental artery, and from a common trunk with anterior-inferior and anterior-superior segmental arteries. Knowledge of these aspects is important both to investigate morphological imaging and performing partial resection of the renal parenchyma.

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