Morphological Variations of Superior Segmental Artery of the Single Renal Artery

Study on corrosion casts

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On a total of 150 renal corrosion casts with a single renal artery, the artery of superior segment was examined. Three morphological types have been highlighted: Type I, in which the superior segmental artery originating directly in the trunk of the renal artery (8.67% of cases); Type II, in which the superior segmental artery arises from the anterior branch of the renal artery (81.33% of cases); Type III, in which the superior segmental artery arises from the posterior branch of the renal artery (10% of cases). In 78% of cases, the superior segmental artery arises independently from the trunk or renal artery branches (anterior or posterior). In 22% of cases, the superior segmental artery realizes a common trunk with one or more other segmental arteries. Knowledge of these aspects is important both to investigate morphological imaging and performing partial resection of the renal parenchyma.

Keywords: kidney; corrosion casts; superior segmental artery; variations.

Medico-surgical literature reviews on morphological variability of impair [1-6] and pair [7-10] collateral branches of the abdominal aorta, highlights the importance of knowledge of these issues in current medical practice. The major morphological variations of abdominal aortic branches are usually classified into: variations of origin [1, 2, 5, 8, 9], variations in number [4, 8, 9] variations of trajectory [3, 4, 10, 11] and variations of distribution [12]. For the renal artery, the most common variations are those of number [2, 3, 9-11] with the presence of accessory or additional renal arteries. In the case of the single renal artery, the most important anatomical variations are the variation of origin and intraparenchymatous distribution. According to Terminologia Anatomica [13], the intraparenchymatous distribution of the renal artery branches has segmental distribution.

Terminologia Anatomica [13] homologates kidney with one renal artery. In accordance with this aspect, the renal artery gives rise to an anterior branch and posterior branch. The anterior branch gives rise to four segmental arteries: superior, anterior-superior, anterior-inferior and inferior. The posterior branch gives rise to only one branch: the posterior segmental artery [14]. In the present study, we analyzed the morphological variability of the superior segmental artery origin and association in case of the single renal artery presence. 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 [14].

The arteries of the superior renal segment show a large degree of morphologic variability regarding their origin and number and also their supplied renal territory [7]. This aspect is very important for the successful of minimally invasive surgery on renal parenchyma.

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 2000-2012 period. Renal pieces were harvested from human cadavers who had no history of renal disease. According with the technique used in the Anatomical Laboratory, the injection of the renal vasculo-ductal systems was performed with Ago II plastic compound (product based on nitrocellulose E550), using the technique described by Nanu, Corondan and Bejan [15], taken and improved later by Matusz [16] and by Zahoi [17]. After injection, the renal pieces were left for 24 h at room temperature for mass polymerization. After 24 h, the renal parenchyma was corroded with technical hydrochloric acid. All procedures for renal 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 homologated by Terminologia Anatomica [13]. The renal corrosion casts were photographed (Nikon D3, Tokyo, Japan, AF-S Nikkor Lens f/14G) and classified according to the present type of major arterial anatomic variation, in particular the origin and distribution of the superior segmental artery.
Results and discussions

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

- type I, in which the superior segmental artery originating directly in the trunk of the renal artery (13/150 cases - 8.67% of cases), with two subtypes: (Ia) in which the superior segmental artery is the first branch that arises from the trunk of the renal artery (9/150 cases - 6% of cases); (Ib) in which the superior segmental artery arises at the same level with other branches of the renal artery (4/150 cases - 2.67% of cases);

- type II, in which the superior segmental artery arises from the anterior branch of the renal artery (122/150 cases - 81.33% of cases), with three subtypes: (Iia) the superior segmental artery, originated independently from anterior branch (93/150 cases - 62% of cases); (Iib) the superior segmental artery originated from a common trunk of anterior-superior and anterior-inferior segmental arteries (12/150 cases - 8% of cases), and (Iic) the superior segmental artery originated from a common trunk with anterior-superior and anterior-inferior and inferior segmental arteries (17/150 cases - 13.39% of cases);

- type III, in which the superior segmental artery arises from the posterior branch of the renal artery (13/150 cases - 10% of cases).

In 78% of cases, the superior segmental artery arises independently from the trunk or renal artery branches (anterior or posterior). In 22% of cases, the superior segmental artery realizes a common trunk with one or more other segmental arteries.

After the descriptions of Graves in 1954 [18], the arterial segmentation of the kidney parenchyma (with five segments) was accepted at the International Anatomical Congress at Wiesbaden in 1965 and included in Nomina Anatomica [19] and after in Terminologia Anatomica [13]. Knowledge of the morphological variability of the superior segmental artery is particularly important in achieving successful the partial nephrectomy of the upper pole [20, 21].

In morphological literature, there are few studies which analyze clearly the superior segmental artery origin [7, 22, 23]. On the studied material (150 kidney corrosion casts), the superior segmental artery arises directly from the renal artery trunk in 8.67% of cases, from the anterior branch in 81.33% of cases, and from posterior branch in 10% of cases.

The superior segmental artery arises most commonly from the anterior branch of the renal artery (Type II), the incidence being 81.33% of the cases, among the 150 corrosion casts from the present study (with higher percentages than in previous reports). The study of Singh et al. [24] reported same segmental artery in 70% of cases, Kher [25] reported in 45.28%, Chandragirish et al. [23] reported in 42.20% of cases, and Verma [26] in only 20.45% of cases. The superior segmental artery arises from the renal artery trunk (Type I) in 8.67% of cases, in the present study (in margin of variation values reported in previous studies), Verma [26] reported the origin of this artery from the junction of the anterior and posterior branches of the renal artery in 16.30% of cases, Chandragirish et al. [23] in 14% of cases, and Kher [25] reported in 5.66% of cases. The superior segmental artery arises from the posterior branch of the renal artery (Type III) in 10% of cases, in the present study (with lower percentages than in previous reports). Kher [25] reported the origin of this artery from the posterior branch of the renal artery in 29.70% of cases, and Chandragirish et al. [23] in 23% of cases.

Using anatomical data is particularly useful in supporting numerous surgical diagnoses, and supporting etiology pathogenesis and specific treatment in many diseases [27-29]. Numerous imaging methods among which highlights MDCT angiography and MR angiography [1-6, 8-11] clearly show anatomical structures, with the possibility of three-dimensional analysis. Making preparations of plastination [30, 31] and computer aided three-dimensional reconstruction and modeling of anatomical images [32], enable three-dimensional analysis and accurate morphometric analysis. Injection of plastics mass in vascular-ductal systems, followed by corrosion of the parenchymal tissues, gives rise to corrosion casts allowing for quality three-dimensional analysis. The viability of these preparations is very high and they can be successfully used in training students and residents in medicine [33, 34].
Conclusions

Analysis of the corrosion renal vascular-ductal systems allows the study of three-dimensional distribution of intraparenchymatous elements. This study showed the origin of the superior segmental artery at three distinct levels: renal artery trunk, anterior branch and posterior branch. Most commonly, the superior segmental artery arises from the anterior branch of the renal artery (81.33%), with three subtypes: arising independently from anterior branch, from a common trunk with anterior-superior and anterior-inferior segmental arteries, and from a common trunk with anterior-superior and anterior-inferior and inferior segmental arteries. Knowledge of these aspects is important both to investigate morphological imaging and performing partial resection of the upper renal parenchyma.

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References