

Location of the ostia of the renal arteries in the aorta

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Summary: A total of 30 adult abdominal aorta specimens dissected from cadavers was used in our study. The location of the ostium of the superior mesenteric a. relative to the ostium of the celiac trunk was identified on the aortic wall. Following this, the locations of the ostia of the renal aa. on the internal wall of the abdominal aorta were examined relative to the ostia of the arteries mentioned earlier. The ostium of the superior mesenteric a. was usually localized on the inferior-right side of the ostium of the celiac trunk. The mean value of the distance between the ostia was 17.9 mm. The ostium of the right renal a. was more cranial than the ostium of the left renal a. (53.3%). However, the ostia of both right and left renal aa. were at the same level in three cases (10%). Locations of the ostia of the renal aa. were usually on the lateral and anterolateral regions of the aortic wall. This study was carried out in order to contribute to selective angiography and surgical interventions for the removal and transplantation of organs, particularly of the kidney. Our results are compared with previous similar studies in man.

Localisation des orifices des artères rénales dans l'aorte

Résumé : 30 aortes abdominales des cadavres d'adultes ont été disséquées. La localisation de l'orifice de l'a. mésentérique supérieure et sa situation par rapport à celui du tronc coeliaque a été identifiée sur la paroi aortique. La localisation des orifices des artères rénales par rapport à ceux de ces deux artères a été déterminée. L'orifice de l'a. mésentérique supérieure est généralement localisé distalement et à droite de celui du tronc coeliaque. La distance moyenne entre les deux orifices était 17,9 mm. L'orifice de l'a. rénale droite se trouvait en position plus crâniale que celui de l'a. rénale gauche (53,3 %). Cependant, les orifices de deux artères droite et gauche se trouvaient au même niveau dans trois cas (10 %). Les orifices des aa. rénales étaient localisés généralement dans les faces latérale et antéro-latérale de l'aorte. Le but de cette étude est d'apporter une contribution à l'angiographie sélective et aux interventions chirurgicales destinées au prélèvement et à la transplantation du rein. Nos résultats ont été comparés à ceux d'autres études réalisées chez l'homme.

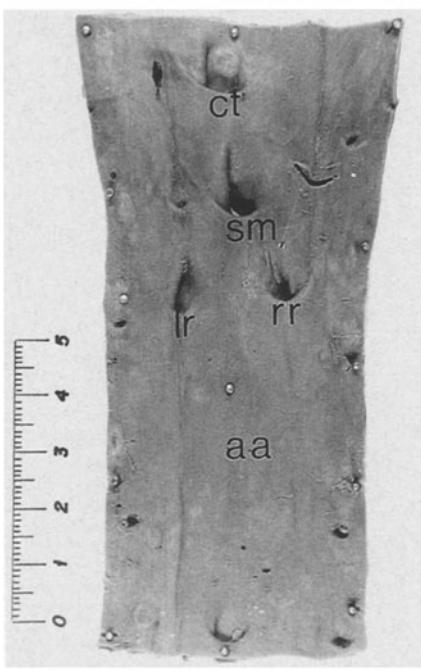
Key words: Renal artery — Angiography — Abdominal aorta — Morphometric analysis

Renal and intrarenal vascular anatomy has been investigated in many previous studies [1, 4, 6, 9, 11-13, 15, 16]. However, studies on location of the ostia of the renal aa. on the aortic wall are scant in the literature [3, 10]. Renal angiography is frequently used in the context of diagnosis and treatments. Therefore, the morphologic features of the ostia of the renal aa. on the aortic wall should be familiar to radiologists, especially those dealing with selective renal angiography.

Materials and methods

Adult abdominal aorta specimens, a total of 30 in number, were obtained from cadavers in the Departments of Anatomy at the Medical Faculties of Gülhane Military Medical Academy, Hacettepe University and 19 Mayis University.

The abdominal aorta of each cadaver was sectioned above the celiac trunk cranially and above the aortic bifurcation caudally, and resected from its branches. The lumen of each specimen was washed under tap water. The anterior wall of the aorta was fixed on a flat surface and the posterior wall was cut mid-sagittally. The cut margins were reflected laterally and also fixed on the flat surface. The ostia of aa. located on the aortic wall were visualised (Fig. 1). Photographs of each specimen were taken together with a 5 cm ruler, and the following distances were measured:

**Fig. 1**

Ostia of the aa. localized on the internal wall of the aorta. *ct*: celiac trunk, *sm*: superior mesenteric a., *lr*: left renal a., *rr*: right renal a., *aa*: abdominal aorta

Results

The ostium of the superior mesenteric a. was located in the inferior and right lateral region of the ostium of the celiac trunk in 22 out of 30 of the cases (73.3%). The mean distance between the two ostia was:

$$V_{CMo} = 18 \text{ mm}$$

The mean distances between the ostia of the renal aa. and the ostia of the superior mesenteric a. and the celiac trunk were collected in Table 1.

As shown in Table 1, the ostium of the right renal a. was closer to the ostium of the superior mesenteric a. than the left. Thus, the ostium of the right renal a. had a cranial location in 53.3% of cases. However, the ostium of the left renal a. was located cranially in 36.6% of the cases. In the remaining 10%, both renal aa. were at the same level.

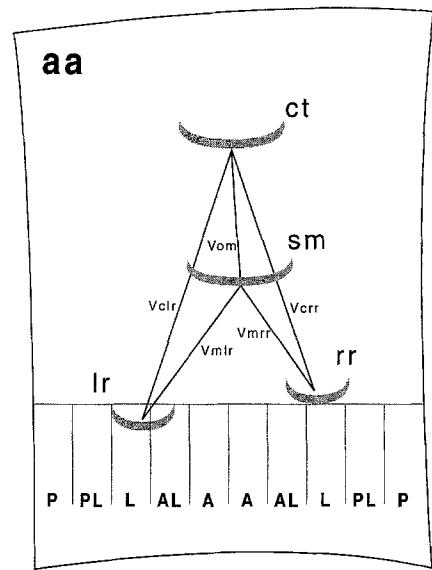
In order to evaluate the distances of the right and left renal ostia from the superior mesenteric and celiac ostia, a parametric two-sample analysis test was done. There was no statistically significant difference between V_{clr} and V_{crr} ($p > 0.05$), however the difference between V_{mlr} and V_{mrr} was found to be significant ($p < 0.05$).

The range of distribution of the locations of the renal aa. on the internal aortic wall is shown in Figure 3. Twenty-nine ostia (48.3%) were located in the lateral, 19 (31.6%) in the anterolateral and 10 in the anterolateral-lateral border zone, one in the posterolateral and one in the posterolateral-posterior border zone.

According to our findings, the locations of the arteries on the aortic wall were as shown in Figure 2.

Discussion

Different studies dealing with the sites of origin of the renal aa. from the abdominal aorta were reviewed in the literature. However, the results of these studies depended only upon external observations and not on identification of the ostia of the renal aa. from within the aorta. A wide range of findings such as anterolateral, lateral and anterior locations were reported in this study [9].

**Fig. 2**

Anatomical configuration of the ostia of the aa. on the aortic wall and the measured distances between them. *aa*: abdominal aorta, *ct*: celiac trunk, *lr*: left renal a., *rr*: right renal a., *sm*: superior mesenteric a., V_{cm} : the distance between the ostia of the celiac trunk and the superior mesenteric a., V_{clr} : the distance between the ostia of the celiac trunk and the left renal a., V_{crr} : the distance between the ostia of the celiac trunk and the right renal a., V_{mlr} : the distance between the ostia of the superior mesenteric and the left renal a., V_{mrr} : the distance between the ostia of the superior mesenteric and the right renal a. The regions on the internal wall of the aorta *P*: posterior, *PL*: posterolateral, *L*: lateral, *AL*: anterolateral, *A*: anterior

Table 1. Mean values of the distances for the left and right renal aa. measured from the critical points

Ostia	Left renal a.	Right renal a.
Celiac ostium	V_{CLR_o} 33.2 mm	V_{CRR_o} 30.0 mm
Superior ostium mesenteric	V_{MLR_o} 17.4 mm	V_{MRR_o} 13.9 mm

The distance between the celiac and the superior mesenteric ostia (V_{CMo}) was found as 18 mm

Publications in the angiographic literature consider the usual position of the renal ostia to be lateral [8] or dorsal [10] on the aortic wall. There are two similar studies dealing with the locations of the renal ostia on the internal wall of the

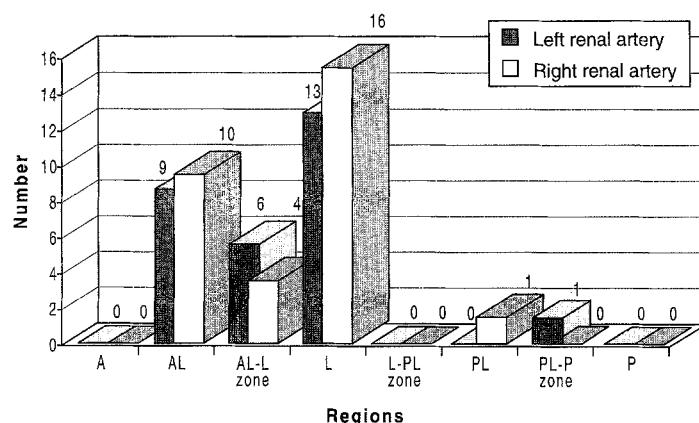
1. the distance between the midpoint of the distal border of the celiac ostium and the midpoint of the distal border of the superior mesenteric ostium (V_{CM}) (Fig. 2),

2. the distances from the midpoint of the celiac trunk to the midpoints of the distal borders of the right (V_{CRR}) and left (V_{CLR}) renal ostia (Fig. 2),

3. the distances from the midpoint of the distal border of the superior mesenteric ostium to the midpoints of the distal border of the right (V_{MRR}) and left (V_{MLR}) renal ostia (Fig. 2).

A horizontal line was drawn at the level of the renal aa. Then, the abdominal aorta was divided into ten equal vertical regions by lines crossing this horizontal line vertically. The locations of the ostia of the renal aa. on the aortic wall, and their cranial or caudal position in relation to the ostium of the superior mesenteric a. were identified (Fig. 2).

A parametric two-sample analysis test was carried out to evaluate the differences between the distances of the right and left renal ostia from the superior mesenteric and celiac ostia.

**Fig. 3**

The range of distribution of the locations of renal aa. on the aortic wall

abdominal aorta [3, 10]. We defined certain such locations by using more significant anatomic landmarks. Moreover, we did not take into account the ostia of multiple renal aa. in order not to affect the data. As stated by many authors, the incidence of multiple renal aa. range from 13 to 60% and the mean value is reported as 30% [9, 14]. We also observed in our series that one specimen had bilateral and four specimens had unilateral multiple renal aa. (16%).

Bauer and Robbins reported that the ostia of the renal aa. were localized on the lateral and anterolateral walls of the aorta in 79 and 15.4% of cases, respectively [3]. However, Ödman and Ranniger found the incidence of a lateral location of the renal aa. to be 55.7% [10]. Our findings were more compatible with the findings of Ödman and Ranniger, since the incidence of lateral and anterolateral locations were 48.3% and 31.6%, respectively. According to Ödman and Ranniger, the ostium of the right renal a. was located more on the anterior wall and that of the left renal a. on the lateral wall of the abdominal aorta. These authors also reported that renal aa. originating from the anterior wall had a more cranial position near the ostium of the superior mesenteric a. [10].

We found that renal ostia on the lateral wall of the abdominal aorta had a cranial, but ostia on the anterolateral wall a caudal position. This result

accounted for the more cranial position of the right renal ostium in relation to the left renal ostium. Extreme (anterior or posterior wall) locations of renal ostia on the aortic wall have been reported to be related to developmental variations of the mesonephric aa. [2, 5, 7].

Although the distance between the ostia of the superior mesenteric a. and the celiac trunk differed in many cases, locations of the renal ostia did not exhibit significant differences. We believe that, for the success of catheterization in selective angiographic procedures, the following anatomical guidelines should be kept in mind:

- The ostium of the right renal a. is usually located on the lateral wall of the abdominal aorta and has a more cranial position than the left. It is nearer to the superior mesenteric ostium and approximately 14 mm distal to it.
- The location of the ostium of the left renal a. is similar to that of the right; however its distance from the superior mesenteric ostium is approximately 17.5 mm distal to it.
- The ostium of the superior mesenteric a. is usually located on the right and approximately 18 mm distal to the ostium of the celiac trunk.

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References

- Anson BJ, Dasesler EH (1961) Common variations in renal anatomy, affecting blood supply, form and topography. *Surg Gynecol Obstet* 112: 439-449
- Bauer FW (1968) The aortic origin of renal arteries. *Arch Pathol* 86: 230-233
- Bauer FW, Robbins SL (1967) A postmortem study comparing renal angiograms and renal a. casts in 58 patients. *Arch Pathol* 83: 307-314
- Boijns E (1959) Angiographic studies of the anatomy of single and multiple renal arteries. *Acta Radiol* 183: 1-135
- Bremer JL (1915) The origin of the renal a. in mammals and its anomalies. *Am J Anat* 18: 179-200
- Cauldwell EW, Anson BJ (1943) Visceral branches of abdominal aorta: topographical relationships. *Am J Anat* 73: 27-57
- Felix W (1912) The development of the urogenital organs. In: *Manual of human embryology*, vol 2. JB Lippincott, Philadelphia, pp 752-979
- Kincaid OW (1966) Normal renal angiogram. In: *Renal angiography*. Medical Publishers, Chicago, p 18
- Merklin RJ, Michels NA (1958) Variant renal and suprarenal blood supply with data on inferior phrenic, ureteral and gonadal arteries: statistical analysis based on 185 dissections and review of literature. *J Int Coll Surg* 29: 41-76
- Ödman P, Ranniger K (1968) The location of the renal arteries. *Am J Roentgenol* 104: 283-288
- Pick JW, Anson BJ (1940) Renal vascular pedicle: anatomical study of 430 body-halves. *J Urol* 44: 411-434
- Ross JA, Samuel E, Miller DR (1961) Variations in the renal vascular pedicle. *Br J Urol* 33: 478
- Sampaio FJB, Aragao AHM (1990) Anatomical relationship between the intrarenal arteries and the kidney collecting system. *J Urol* 143: 679-681
- Sampaio FJB, Passos MARF (1992) Renal arteries: anatomic study for surgical and radiological practice. *Surg Radiol Anat* 14: 113-117
- Smith GT (1963) The renal vascular patterns in man. *J Urol* 80: 275-288
- Weinstein BB, Coutyss EH, Derbes VJ (1940) Renal vessels in 203 cadavers. *Urol Cutan Rev* 44: 137-139

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