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A Primer to the Innate Renal Artery Ostium Flow Diverter

Quenton Wessels[1]*, Piet Vincentius Hoogland[2], Adelé du Plessis[1] and Wickus Grobler[1]

[1]Department of Anatomy, School of Medicine, University of Namibia, Windhoek, Namibia

[2]Department of Anatomy and Neurosciences, Institute for Clinical and Experimental Neurosciences (ICEN), VU University Medical Centre, Amsterdam, The Netherlands

***Corresponding Author:** Quenton Wessels, Senior Lecturer, Department of Anatomy, School of Medicine, University of Namibia, Windhoek, Namibia.

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Abstract

The innate intimal flow diverter is an anatomical structure associated with directing blood flow from the abdominal aorta towards the kidneys at the aortic renal artery ostia (RAO). Cadaveric dissections indicate that the flow diverter, immediately preceding the RAO, can either be V- or U-shaped. Our initial data suggest a higher prevalence of U-shaped morphotypes among Caucasians. Cadaveric dissections of this study indicate that atherosclerotic fibrous plaques on the base (caudal end) of the RAO were exclusively associated with U-shaped flow diverters. It was also noted that the morphology of the flow diverter itself can be influenced by the presence of atherosclerotic plaques. The findings presented here call for further investigation into the interplay between the different haemodynamic effects of V- and U-shaped flow diverter morphotypes and the tendency of atherosclerotic plaque formation.

Keywords: *Renal Artery; Ostium; Innate; Flow Diverter; Abdominal Aorta; Atherosclerosis*

Introduction

Much has been written on the anterior and paired visceral branches of the abdominal aorta, their anatomical variations, and related pathologies. The same applies for the renal arteries, especially concerning their origin in relation to the abdominal aorta, movement during respiration and blood flow velocity [1-4]. Yet, some aspects remain unexplored such as the intimal surface anatomy and the geometry of the renal artery ostium (RAO) flow diverter. This anatomical structure was first described by Neufeld and colleagues in 2010 in a porcine model [5]. They described the RAO flow diverter as a specialised intimal thickening in the form of a cap which serves to direct the flow of blood towards the kidneys. Histologically, it is composed of a dense core of collagen and projects into the aortic lumen [5]. To our knowledge, the morphology of these innate flow diverters remains unexplored in humans. The work presented here serves as a primer to further research being done on the RAO flow diverter in humans.

Materials and Methods

This was an exploratory cadaveric study conducted at the University of Namibia, School of Medicine, during routine dissections of formalin-embalmed adult cadavers from the Western Cape, South Africa. A total of 36 renal artery ostia of ten male and eight female cadavers with an age range of between 25 and 95 years (mean age 55.4 ± 20.9), were dissected and described. The ethnicity of the cadavers included 10 individuals of Mixed-race (5 males and 5 females), three of African descent (two males and one female) and five Caucasians (three males and two females).

Results

In situ, the RAO were observed as distinct anatomical structures (Figure 1A). Of interest is that these flow diverters are not only limited to the renal arteries but can also be found in association with other branches of the abdominal aorta, especially the superior and inferior mesenteric arteries (Figure 1A). The findings of this study, although limited by a small sample size, suggest the existence of two distinct morphotypes of the RAO flow diverters (Figure 1A and 1B). We found that these diverters can be V- and U-shaped (Figure 1C and 1D): five individuals (28%) presented with bilateral V-shaped and 12 with U-shaped (67%) flow diverters (Table 1).

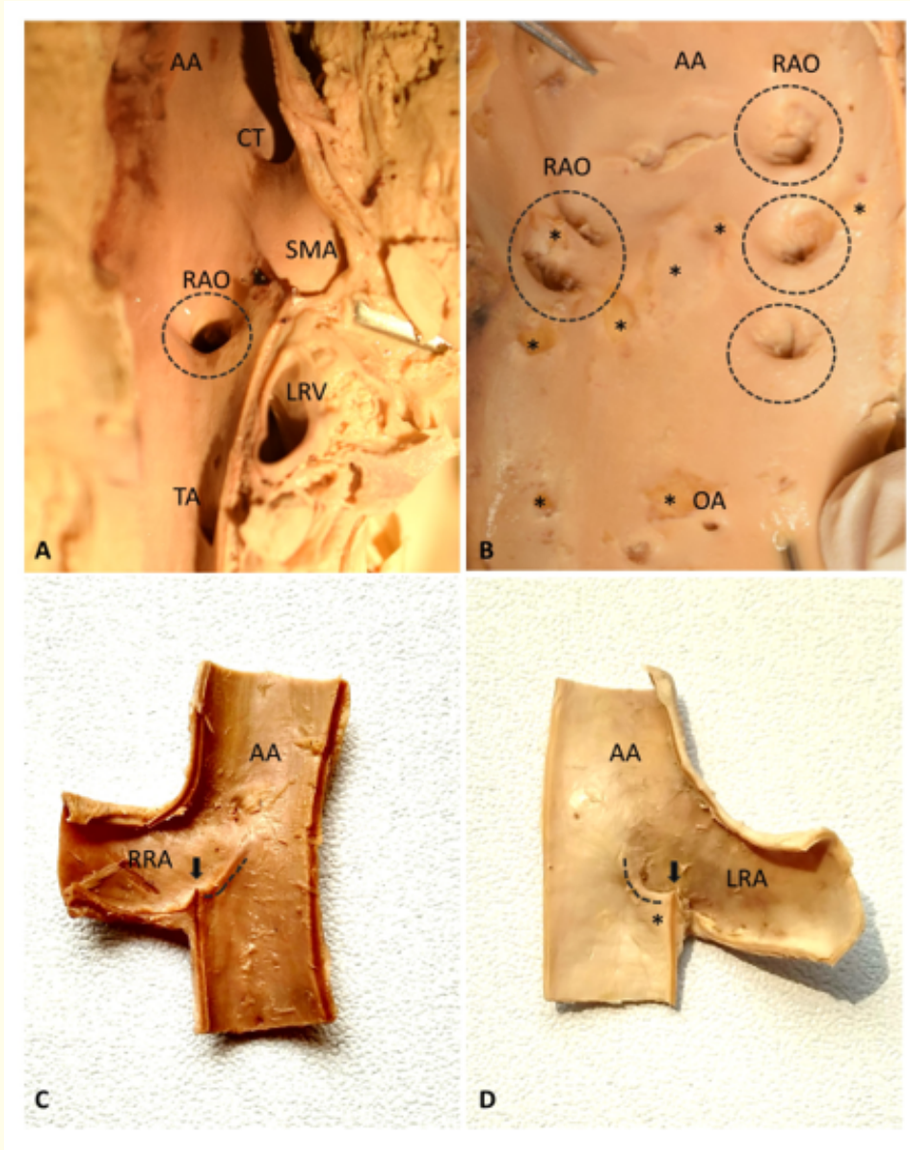

Figure 1: *A: A sagittal section of the abdominal aorta of an African male (K24/18) demonstrating the RAO and a V-shaped flow diverters (note the prominent V-shaped ostial diverter of the testicular artery). B: The abdominal aorta of a Caucasian female (K74/29) with multiple U-shaped RAO flow diverters associated with three left sided renal arteries and two on the right (dashed circles). The asterisks indicate the presence of elevated atherosclerotic fibrous plaques. C and D: Coronal dissections of the two morphotypes of flow diverters which can either be V-shaped (dashed line in C) or U-shaped (dashed line in D). In both types, the root of the flow diverter extended well into the lumen of the abdominal aorta (the arrows indicate the lowest and thus midpoint of the diverters). The asterisk in D denotes the presence of an elevated atherosclerotic fibrous plaque. Legend: AA: Abdominal Aorta; CT: Coeliac Trunk; LRA: Left Renal Artery; LRV: Left Renal Vein; OA: Ovarian Artery; RAO: Renal Artery Ostium; RRA: Right Renal Artery; TA: Testicular Artery.*

One cadaver presented with a V-shaped right and U-shaped left diverter (Table 1). It appears that the U-shaped morphotype is prevalent in cases where more than one renal artery is present (Table 1, K74/29 and Figure 1B). We also found that the morphology of the flow diverter can be influenced by the presence of an atherosclerotic fibrous plaque. In these cases, the diverters were less pronounced at their caudal end of the renal ostium. The base of these diverters extends well into the lumen of the abdominal aorta and lends its distinct morphology (Figure 1C and 1D). From their superior origin and in a coronal plane, the renal arteries gradually curve away from the aorta whilst the flow diverter appears to follow this curvature at its midpoint. Of particular interest is the presence of atherosclerotic fibrous plaques on the base (caudal end) of some of the U-shaped diverters whilst none were associated with the V-shaped diverters (Table 1, cases K18/14, K21/14 and K197/12). Age, lifestyle and genetic factors might further shed light on these morphological differences. Both morphotypes of the flow diverters were seen in individuals of Mixed-race and African descent whilst the Caucasian cadavers primarily presented with U-shaped flow diverters (Table 1).

No.	Reference	Age	Gender	Ethnicity	RAO diverter	
					Left	Right
1	K68/10	25	F	Mixed-race	U	U
2	K18/14	47	M	Mixed-race	V	V
3	K45/14	61	M	Mixed-race	U	U
4	K21/14	30	F	Mixed-race	U	V
5	K58/11	83	M	Mixed-race	U	U
6	K47/14	69	M	Mixed-race	U	U
7	K29/14	36	F	Mixed-race	V	V
8	K33/18	26	F	Mixed-race	V	V
9	K37/18	43	M	Mixed-race	V	V
10	K41/18	73	F	Mixed-race	U*	U*
11	K46/14	58	M	African	U*	U
12	K197/12	40	F	African	U*	U
13	K24/18	36	M	African	V	V
14	K74/29	67	F	Caucasian	UU*,U*	UU
15	K95/74	72	M	Caucasian	U**	U*
16	K95/90	95	F	Caucasian	U*	U*
17	K48/14	78	M	Caucasian	U	U
18	K92/11	58	M	Caucasian	U	U

Table 1: *The presence and morphology of the renal artery ostium (RAO) flow diverter.*

**: Denotes the presence of a raised lesion (atherosclerotic fibrous plaque).*

***: Denotes the presence of a ruptured atherosclerotic fibrous plaque.*

Legend: U: U-shaped; V: V-shaped; UU: Double Renal Artery; UUU: Triple Renal Artery.

Discussion

The findings reported here merit further investigation into the correlation between specific flow diverter morphotype-associated haemodynamics, and the possible pathogenesis and prevalence of atherosclerotic changes. The development of atherosclerotic plaques are more likely at arterial branch points [6]. The formation of atherosclerotic plaques, based on our observations, are not limited to the caudal end of the flow diverters as reported by Neufeld., *et al.* but have been found around the renal artery ostium itself. In addition, their work demonstrated the relationship between the occurrences of flow eddies by the caudal end of the flow diverters *in vivo* and the subsequent deposition of low-density lipoproteins [5]. This provides an explanation for the formation of atherosclerotic plaques in this area.

The works of Neufeld., *et al*. and Albert., *et al*. focused primarily on the RAO flow diverters, but in this study we have found that these flow diverters are associated with other branches of the abdominal aorta as well [5,6]. Furthermore, additional *in vivo* studies have the potential to rule out the possibility that morphology of these flow diverters is the result of the embalming procedure used. However, the work of Neufeld., *et al*. used fresh and saline preserved porcine aortic samples when they made their discovery. The histological findings of their work further indicated that the intima and medial layers of the flow diverters were thickened, forming a distinctive protrusion and an anatomical entity [5]. We therefore feel confident that the innate flow diverters are not an embalming artefact, but a true anatomical structures.

Conclusions

The authors report two morphotypes of the innate RAO flow diverters in humans. Additional evidence suggests that similar blood flow regulators are associated with other branches of the abdominal aorta. The RAO flow diverters are distinct anatomical structures that require further investigation in order to understand their normal physiological role. Research on the structural differences of the RAO flow diverters *in vivo* will further aid our understanding of renal haemodynamics and atherogenesis.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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