

## CORRELATION BETWEEN VARIATIONS IN THE TERMINATION OF THE HUMAN RENAL VEINS AND THE FREQUENCY OF VALVES

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MIRANDA NETO, M. H.; MOLINARI, S. L.; CHOPARD, R. P.; BIAZOTTO W.; SANT'ANA, D. M. G. Correlation Between Variations in the Termination of the Human Renal Veins and the Frequency of Valves. *Arq. Ciênc. Saúde Unipar*. 4(3): 201-205, 2000.

**ABSTRACT:** The main trunk and the right and left cavo-renal junctions of 100 corpses were studied with the purpose of investigating possible relationships between the presence of valves and the variations in the termination of the renal veins. Developed valves were not found in the left renal vein. In the right renal vein, developed valves were found most frequently when the right cavo-renal junction occurred above the left junction, i.e., in 10 of 16 cases (62.5%), and in cases of double right renal veins, i.e., 14 of 24 cases (58.3%). When the right and left cavo-renal junctions occurred at the same level, developed valves were found in 10 of 27 cases (37%) and when the right junction occurred below the left one they were found in seven of 31 cases (22.6%). Rudimentary valves were found in the right renal vein in 19 cases and in the left renal vein in 12 cases. The authors discuss the relationship between morphologic type of valves and the level of termination of the renal veins in the vena cava and the angle of the cavo-renal junctions.

**KEY WORDS:** anatomical variations; renal veins; valves.

## CORRELAÇÃO ENTRE VARIAÇÕES DA TERMINAÇÃO DAS VEIAS RENAI E FREQUÊNCIA DE VALVAS

MIRANDA NETO, M. H.; MOLINARI, S. L.; CHOPARD, R. P.; BIAZOTTO W.; SANT'ANA, D. M. G. Correlação entre Variações da Terminação das Veias Renais e Frequência de Valvas. *Arq. Ciênc. Saúde Unipar*. 4(3): 201-205, 2000.

**RESUMO:** Foram estudados o tronco principal e as junções cavo-renais direita e esquerda de 100 cadáveres com o objetivo de investigar as possíveis relações entre a presença de valvas e as variações na forma de terminação das veias renais. As valvas desenvolvidas não foram encontradas na veia renal esquerda. Na veia renal direita as valvas desenvolvidas encontravam-se com maior frequência nos casos em que a junção cavo-renal direita ocorria acima da esquerda, 10 entre 16 casos (62,5%) e nos casos de veias renais direitas duplas, 14 entre 24 (58,3%). Nos casos de junção cavo-renal direita ao mesmo nível da esquerda foram encontradas em 10 entre 27 casos (37%) e nos casos de junção cavo-renal direita abaixo da esquerda em 07 entre 31 casos (22,6%). As valvas rudimentares foram encontradas na veia renal direita em 19 casos e na veia renal esquerda em 12 casos. Os autores discutem as relações dos tipos morfológicos das valvas com o nível de terminação das veias renais na veia cava e com o ângulo formado pelas junções cavo-renais.

**PALAVRAS-CHAVE:** valvas; variações anatômicas; veia renal.

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## Introduction

Many authors have reported the presence of developed and rudimentary valves in the right and equally numerous are the left renal veins (KAMPMEIER & BIRCH, 1926; TAKARO *et al.*, 1970; McDONALD & HUTTON, 1977;

MIRANDA-NETO, 1992) and equally numerous are the reports concerning anatomical variations of the renal veins (McCLURE & BUTLER, 1925; PICK & ANSON, 1940; DiDio, 1956; BORRELLI *et al.*, 1973; SONES *et al.*, 1978. However, we did not find studies correlating the presence of valves with anatomical variations. Thus, we carried out this investigation in order to determine the incidence of valves and of variations at the level of the main trunk and termination of the renal veins, as well as possible relationships between these variables.

## Material And Method

Material was obtained from formalin-preserved cadavers used for Human Anatomy teaching at the Medical School of São Paulo University (20 cases) and from the State University of Maringá (10 cases). Additional samples (70 cases) were obtained a few hours after death from cadavers at the Death Verification Service of the Capital, São Paulo city morgue.

The material consisted of right and left renal veins from 100 cadavers of both leucodermic and melanodermic individuals, 53 males and 47 females.

In each case, the mesentery root was resected and an incision was made in the posterior parietal peritoneum to expose the inferior vena cava and the renal veins. Next, the angles between the renal veins and the inferior vena cava were measured on the frontal plane, placing a cotton string along the median line of the inferior vena cava, as well as along the median line of the right and left renal veins; the angles of intersection of these strings were measured as illustrated in figures 1 to 9 by dashed lines, using a GEO-DREIECK Nr 1550 compass.

The renal veins were then opened lengthwise for observation of their internal features.

Selected cases were photographed with an OMPI-Zeiss stereomicroscope.

Data were analyzed statistically using the computer Program of Statistical Support (PAE) developed by the Department of Statistics of the State University of Maringá. Data concerning the morphology and incidence of valves were subjected to the Z test for comparison of proportions. Arithmetic means and

standard deviations of the angles of the right and left cavo-renal transitions were calculated for veins with developed, rudimentary or absent valves and analyzed for significance by Student's t test. The significance level adopted for the tests was 5%.

## Results

In 94 cases (94%) the left renal vein ended as a single trunk at the level of the border of the body of the second lumbar vertebra, immediately below the superior mesenteric artery. In 49 of these 94 cases (52.1%) the vein was ascending (figure. 1) and in 47.9% it was transverse (figures. 2 and 3), with angles varying from 45 to 90° relative to the inferior vena cava.

In three cases the left renal vein was double, the superior one being ascending and pre-aortic and the inferior one descending and retro-aortic (figure. 4). In the remaining three cases, the vein was descending and retro-aortic, with its trunk bifurcating before termination and giving rise to two smaller trunks which reached the vena cava at the level of the third and fourth lumbar vertebrae, respectively (figure. 5).

The termination of the right renal vein was single in 74 of 100 cases, with angles varying from 30 to 130° relative to the inferior vena cava. In 16 cases, termination of the right renal vein occurred above the left vein, at the level of the first lumbar vertebra (figure. 3). In 27 it occurred at the same level as the left vein, i.e. at the level of the superior border of the body of the second lumbar vertebra (figure. 2), and in 31 it occurred below the left cavo-renal junction, at the level of the inferior border of the body of the second lumbar vertebra (figure. 1). In 24 cases (24%) the right renal vein was double with parallel terminations of angles varying from 55 to 90° (figures. 6, 7 and 8). Termination of these veins relative to the left renal veins was as follows: superior at the level of and inferior below the left one (eight cases, fig. 6); superior above and inferior below the left one (six cases, figure. 8); both below the left one (seven cases, figure. 7).

In two cases (2%) the right renal vein was triple with an ascending course and an angle of 70° (figure. 9). The uppermost one was at the level of the left renal vein and the other two were below it.

Developed valves were present in the right cavo-renal junction in 36 cases (figure. 10) and on the wall of the main trunk of the right renal veins in seven cases (parietal valves), but were not found in the left main trunk or cavo-renal transition.

Developed valves were found most frequently when the right cavo-renal junction occurred above the right one, in 10 of 16 cases (62.5%), and when the renal veins were double, in 14 of 24 cases (58.3%). In cases in which the right cavo-renal junctions were at the same level as the left ones, developed valves were found in 10 of 27 cases (37.0%), and in cases in which the right cavo-renal junctions were below the left ones, developed valves were found in seven of 31 cases (22.6%). The two cases of triple right renal veins showed the presence of developed valves.

Data referring to the incidence of developed valves in cases in which the right cavo-renal junctions were above (10/16=62.5%) and below (7/31=22.6%) the left ones attained significance when subjected to the test of differences between proportions ( $Z=2.699$ , critical value=2.02).

In 40 of the 43 cases (93.0%) in which developed valves were present, the right renal vein was ascending with angles varying from 30 to 85° and in the remaining three (7%) the vein was transverse with angles of 90°, with the mean angle for these 43 cases being 66.7°. Rudimentary valves were also found, which were composed of short sheets forming a small projection towards the venous lumen (figure. 11).

Of the 19 cases in which rudimentary valves were present in the right renal vein, 11 (57.9%) were ascending, seven (36.8%) were transverse and one (5.3%) was descending, the mean angle of the cavo-renal junction being 83.05°.

Among the 39 cases in which the right main trunk and the cavo-renal transition had no valves, the vein was ascending in 17 (43.6%), descending in one (2.6%), and transverse in 21 (53.8%), with a mean angle of 84.87°.

Significant differences were found when comparing the mean angles of the right cavo-renal junctions exhibiting developed valves ( $66.77 \pm 16.61^\circ$ ) and lacking valves ( $84.87 \pm 11.13^\circ$ ) or having rudimentary valves ( $83.05 \pm 12.59$ ), with the t test revealing values of 5.8 and 3.84, respectively (critical value=2.0).

No significant differences were found between the mean angles of the right cavo-renal junctions lacking valves ( $84.87 \pm 11.13^\circ$ ) and the mean angles of those with rudimentary valves ( $83.05 \pm 12.59$ ;  $t=0.05$ ; critical value=2.0).

Rudimentary valves were found in the left renal vein in 12 of 100 cases (12%); in six of these they were located on the ostium of the cavo-renal junction and in the other six on the renal vein wall halfway between the hilum and the cavo-renal junction; the mean angle of the valvulated left cavo-renal junctions was  $91.66 \pm 12.49^\circ$ , while the mean angle in the 88 cases in which this junction lacked valves was  $83.23 \pm 8.41$ . Comparison of

these means revealed a significant difference ( $t=3.13$ ; critical value=2.0).

## Discussion

Analysis of our results showed that at the level of the right cavo-renal junction, the variations are more frequent, either in terms of the level of their occurrence or in relation to the additional vessels, in agreement with ANSON & DASELER (1961), who stated that the simplified pattern of renal pediculum described in some textbooks of Anatomy and Surgery is found in only about ¼ of cases.

The occurrence of double right renal veins (24.0% of the present cases) was also reported by REIS & ESENTER (1959) in 10.2% of their cases, by ROSS *et al.* (1961) in seven of 34 cases, and by MONTE (1979) in 33.3% of their cases, and was also reported by BORRELLI *et al.* (1973).

In only three of the 100 cases studied here did we observe a double trunk of the left renal vein, in contrast to the right renal vein, in which the trunk was multiple, double or triple in 26.0% of cases. The presence of a multiple left renal vein was mentioned by PICK & ANSON (1940) in 1% of cases, in 0.8% by REIS & ESENTER (1959), in one of 34 cases by ROSS *et al.* (1961), in one of 40 cases by SONES *et al.* (1978), and in 13.3% of cases by MONTE (1979).

According to McCLURE & BUTLER (1925) and REIS & ESENTER (1959), the presence of double renal veins represents the persistence of the embryonic pattern, characterized by two embryonic renal veins (ventral and dorsal). These authors pointed out that typically the dorsal branch atrophies and the ventral one persists, forming the pre-aortic left renal vein. When the dorsal branch persists, a retro-aortic renal vein also arises.

The occurrence of a retro-aortic descending left renal vein observed in our study in three of 100 cases was also reported by PICK & ANSON (1940) in seven of 202 cases, by REIS & ESENTER (1959) in 12 of 500 cases, by SONES *et al.* (1978) in one of 40 cases and by HUBLER *et al.* (1983) in two of 28 cases. Possible correlations between this variation and the occurrence of varicocele on the left were pointed out by RIEDL (1980), while HUBLER *et al.* (1983) commented on the surgical importance of the knowledge of this variation, and LINSELL *et al.* (1987) discussed the possibility of fistula formation between an aortic aneurysm and the retro-aortic left renal vein. Information about the composition of the retro-aortic segment of the left renal vein has been reported by MIRANDA-NETO *et al.* (1997).

The presence of developed valves was previously mentioned by KAMPMEIER & BIRCH (1926)

and TAKARO *et al.* (1970) in 10 of 20 cases in the right renal vein and in 5 of 20 cases in the left renal vein, and by McDONALD & HUTTON (1977) in one case; our results revealed the presence of developed valves in 43 of 100 right renal veins, but not in the main trunk or in the left cavo-renal junction.

Observation and statistical analysis of the present data showed that the mean angle of the right cavo-renal junctions with developed valves (66.77°) was smaller than the mean angle when valves were not present (84.87°) or when rudimentary valves were present (83.05°).

In our view, the predominance of developed valves when the right renal vein is ascending, 40 of 43 cases (93.0%), may represent a device to prevent reflux during overloading of the right atrium, since the lumen of the renal vein facing the cranial direction would be easily affected, while the transverse terminations would prevent the reflux by themselves.

The possible hemodynamic inter-ference caused by proximity to the heart and its influence on the existence of developed valves are suggested by the fact that the more cranial the right cavo-renal junction, the greater the incidence of developed valves; thus, the highest percentage of developed valves, 10 of 16 cases (62.5%), was observed when the right cavo-renal junction was above the left one. In the junctions at the same level this incidence was of 37.0% (10 of 27 cases), and it was even lower when the right junction occurred below the left junction, seven of 31 cases (22.6%). We also observed a high incidence of developed valves where the renal veins were double (58.3%), a feature that was not investigated by others.

We can thus state that the developed venous valves in the right main trunk and cavo-renal junction are related to the obliquity, level of the junction and number of renal veins.

CHOPARD *et al.* (1994) compared the incidence of valves in the renal veins of children aged one day to two years, and of adults aged 19 to 45 and 55 to 82 years, and did not find significant differences between groups. They observed that in older individuals the valves became richer in collagen fibers and thicker; on the other hand they noted that the muscle fibers of the venous wall experienced progressive atrophy with aging, while the bundles of elastic fibers underwent the reverse process, and in this way the renal vein lost its propulsive capacity. They argued that the changes in the valves might serve to restrict the backflow and avoid increased pressures in a vascular bed characterized by thin-walled veins with reduced propulsive capacity.

The presence of rudimentary valves in the renal veins was observed on the right in 19 of 100 cases and

on the left in 12 of 100 cases. TAKARO *et al.* (1970) found rudimentary valves on the right in 10 of 20 cases and on the left in six of 20 cases.

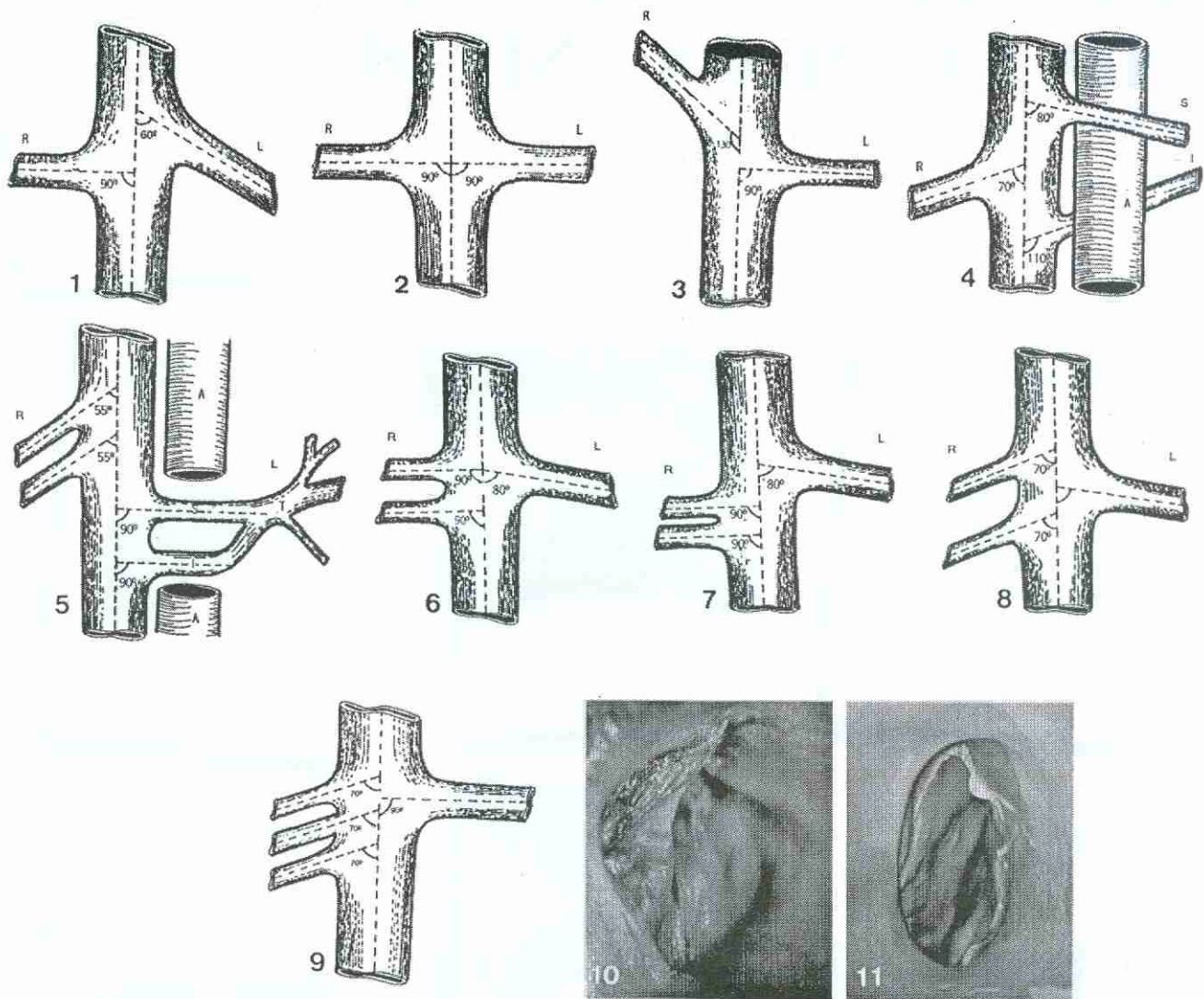
In spite of the high incidence of valves in the renal veins, Anatomy textbooks do not provide information that could make Medical students aware of this phenomenon, and thus prevent future unnecessary procedures and diagnostic mistakes from occurring, as reported by McDONALD & HUTTON (1977): unaware of the presence of valves in the renal veins, after a venography they subjected a patient to venotomy for removal of a thrombus and during surgery verified the presence of the competent valve that had been the cause of the false diagnosis.

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Recebido em: 20/07/2000

Aceito em: 22/11/2000



**Figure 1 - 9** - Variations in the termination of the human renal veins.

**Figure 10** - Developed valves.

**Figure 11** - Rudimentary valves.