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ORIGINAL ARTICLE

# Retrocaval ureter: a meta-analysis of prevalence

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## Abstract

**Introduction** Retrocaval ureter is a congenital abnormality of the right ureter, which has been shown, in rare cases to cause clinical symptoms, mainly due to the development of ureterohydronephrosis.

**Purpose** The purpose of this article is to identify the prevalence of the retrocaval ureter, and to emphasize its clinical and surgical importance.

**Design** A meta-analysis of prevalence, on cases obtained from PubMed, Web of Science, and Scopus databases.

**Results** A total number of 13 studies contained data that allowed us to estimate the prevalence of the retrocaval ureter, which was identified overall in 9 cases, out of 18,493 subjects. The overall prevalence of retrocaval ureter was 0.13%, with a 95% confidence interval between 0.06 and 0.27%. There was no publication bias, all studies being under the funnel.

**Conclusions** The overall prevalence of retrocaval ureter is 0.13%. Even if this is obviously a rare condition, its presence must be suspected by practitioners, especially in the presence of urological symptoms without a clear cause.

**Keywords** Retrocaval ureter · Circumcaval ureter · Preureteral vena cava · Prevalence · Congenital abnormality of the vena cava

## Introduction

The retrocaval ureter, also known as the circumcaval ureter, or preureteral vena cava, is a congenital condition characterized by the persistence of the posterior subcardinal vein on the right, which causes the proximal ureter to deviate medially, behind the inferior vena cava (IVC), before resuming its natural course anteriorly and laterally [17]. It has been initially described by Hochstetter in 1893, which suggested it to be a developmental abnormality of the IVC [9]. Many authors prefer using the term "preureteral vena cava", as the cause of this variant is actually a caval developmental abnormality, and not a ureteral one [31].

From a clinical point of view, the presence of a retrocaval ureter was usually associated, with the development of progressive ureterohydronephrosis with consecutive right flank pain [22], but many cases are clinically silent.

Since its initial description, the condition has been usually reported on case reports in humans. The prevalence of this anatomical variant has been estimated at around 0.1% [14, 23, 32], but the number of studies actually evaluating it is very low.

The purpose of this article was to identify the prevalence of the retrocaval ureter, and to emphasize its clinical and surgical importance.

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## Materials and methods

We performed the study according to the PRISMA guidelines for reporting systematic reviews and meta-analyses of observational studies in epidemiology [19].

### Selection criteria

Inclusion criteria: studies that contained data from which we were able to estimate the prevalence of the retrocaval ureter. We used as exclusion criteria: (1) the absence of relevant information to reconstruct the data needed for analysis; (2) studies with less than 20 subjects; (3) case series/case reports without a specification of the study population from which the cases were drawn upon and without a specific detection algorithm; (4) studies performed on other species.

### Search method

We analyzed the results obtained from three databases: Web of Science, Scopus, and PubMed, using the following keywords: "circumcaval ureter", "preureteral vena cava", "retrocaval ureter", with a timeframe that ranged from the beginning of each database to June 2018. We preferred not to use additional, restrictive criteria (e.g., article type) as other assortments (letters, case presentations, reviews) might have added relevant data to the meta-analysis (discussions, finding other appropriate articles). The reference list of each relevant one was scrutinized for other, potentially relevant studies to be included in the meta-analysis. The references, abstract, and full text (if available) were imported in the Mendeley Desktop software.

### Data collection and analysis

For each study, two reviewers extracted the data separately and included it in Excel datasheets. We summarized the following information: study, name of the authors, year, total number of cases, country, number of cases with retrocaval ureter, and the detection method.

### Risk of bias

The risk of bias was assessed separately, for each case, by two reviewers. We analyzed here the selection bias (inclusion and exclusion criteria, type of study), multiple publication bias, measurement bias (method used, with autopsy and high-resolution CT imaging being considered to have lower bias), statistical reporting bias (statistical analysis performed with the data, complete description of the data). Based on these elements, we separated the studies in three subgroups: high risk of bias, moderate risk of bias, and low risk of bias.

### Quality assessment

Quality assessment was performed using the Quality in Prognostic Studies tool from which we removed study attrition (which was considered not relevant for a prevalence study). For each remained subscale (study participation, prognostic factor measurement, outcome measurement, study confounding, statistical analysis, and reporting), we graded each study as low quality (0 points), intermediate quality (1 point) or high quality (2 points).

### Statistical analysis

We determined the effect size using a random effects model computed in Comprehensive Meta-Analysis version 2. For the analysis of publication bias, we used the funnel plot, the Duval and Tweedie's Trim and Fill and Egger's regression intercept.

## Results

### Search synthesis

During the initial database research, we obtained 1762 articles (Table 1) from which, after deleting duplicates and irrelevant studies we selected 34 to be further scrutinized. By analyzing their references, we found another four potentially relevant articles that were also downloaded. From the 38 articles, 13 were included in the final analysis of prevalence. Details about the search synthesis are presented in Fig. 1. We have detailed the papers contained in the meta-analysis in Table 2.

### Bias and quality

From the 13 included articles, 2 were considered of a high quality (between 6 and 8 points), 6—of a medium quality (between 3 and 5 points), 4—of a low quality (between 0

**Table 1** Keyword search

| Keyword search | PubMed | Scopus | Web of knowledge | Number of articles |
|---|---|---|---|---|
| Preureteral vena cava | 9 | 10 | 7 | 26 |
| Circumcaval ureter | 429 | 69 | 62 | 560 |
| Retrocaval ureter | 409 | 525 | 242 | 1176 |
| Total | 847 | 604 | 311 | 1762 |

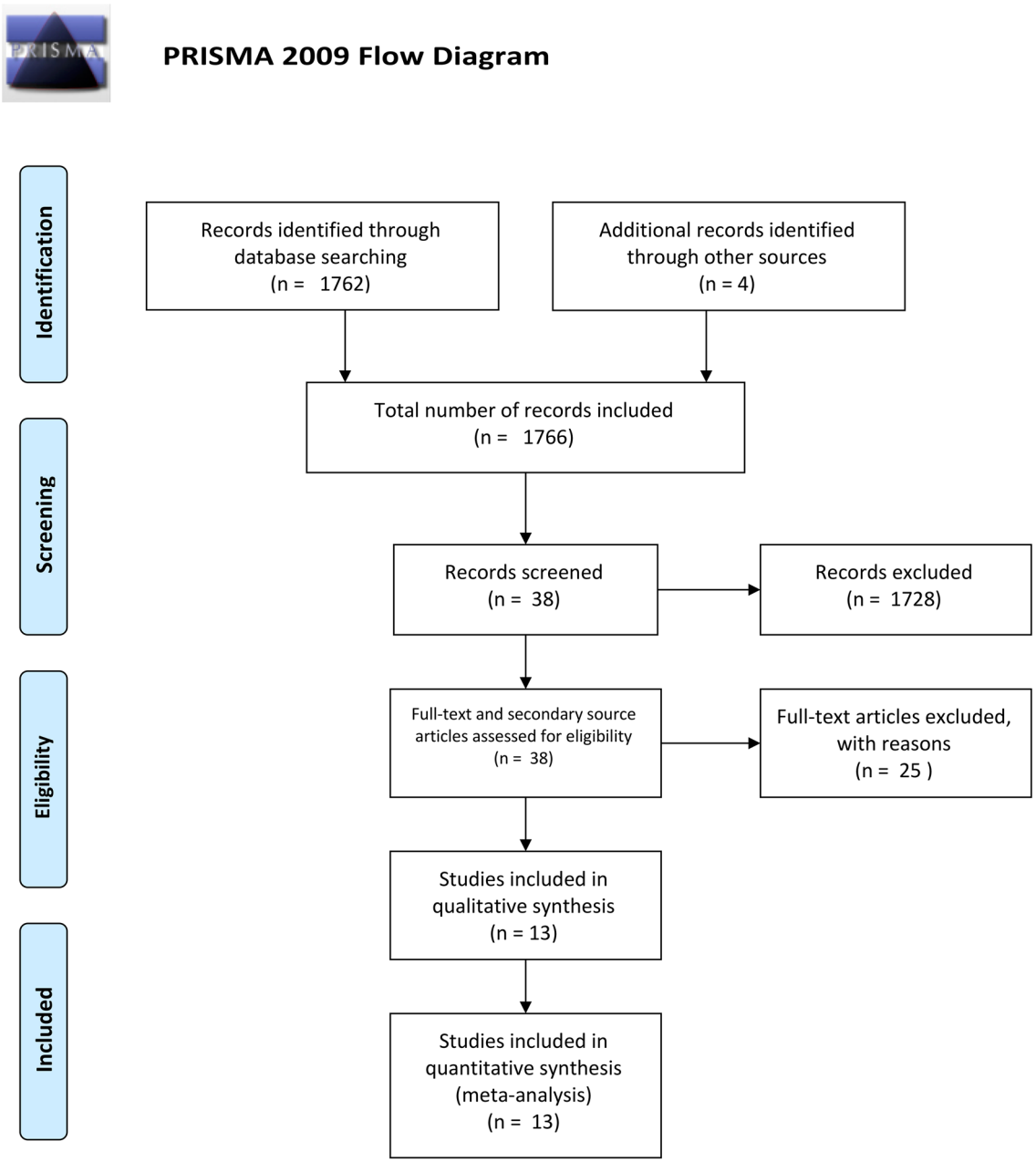


**Fig. 1** Search synthesis. PRISMA flow diagram. The PRISMA statement and the PRISMA explanation and elaboration document are distributed under the terms of the creative commons attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited [19]

and 2 points), and for 1 we could not obtain a full electronic text of the manuscript, and therefore the quality score could not be computed. A low bias was assessed in three articles, a moderate bias in eight, and a high bias in

**Table 2** Studies included in the analysis

| Study | Method | No subjects | No positive cases |
|---|---|---|---|
| Mayo [18] | CT | 1140 | 1 |
| Koc [15] | CT | 1120 | 1 |
| Shindo [28] | Surgery | 166 | 1 |
| Hoeltl [10] | Autopsy + CT + Surgery | 5089 | 0 |
| Trigaux [33] | CT | 1014 | 0 |
| Gillaspie [7] | Autopsy | 33 | 0 |
| Namasivayam [20] | CT | 48 | 0 |
| Holt [11] | Surgery | 278 | 0 |
| Dial [5] | Autopsy | 1600 | 1 |
| Adachi [1] | Autopsy | 1055 | 2 |
| Anson [2] | Autopsy | 570 | 1 |
| DeCarlo [4] | Autopsy | 4185 | 1 |
| Ichikawa [13] | CT | 2195 | 1 |

one (for one article the bias was not computed as we could not obtain a full electronic text of the manuscript).

## Prevalence of the retrocaval ureter

A total number of 13 studies contained data that allowed us to estimate the prevalence of the retrocaval ureter, which was identified overall in 9 cases, out of 18,493 subjects. Five studies included in the analysis were performed on CT scans, two - on patients undergoing surgery, five on autopsy reports, and one contained three separate groups (a surgery cohort, an autopsy cohort, and a CT cohort).

The overall prevalence of retrocaval ureter was 0.13%, with a 95% confidence interval between 0.06 and 0.27%. See Fig. 2 for details

The heterogeneity of the studies was low, with an $I^2$ value of 42% and a $Q$ value of 10.36.

There was no publication bias, all studies being under the funnel (Fig. 3). Also, the Duval and Tweedie's trim and fill

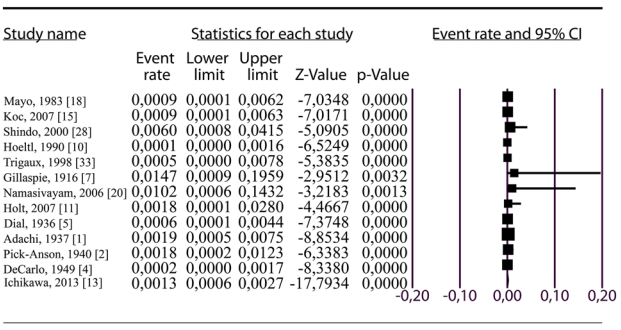


**Fig. 2** Forest plot—meta-analysis of prevalence for retrocaval ureter

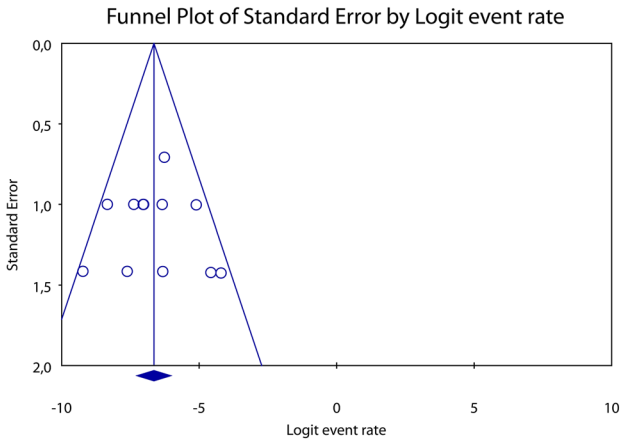


**Fig. 3** Funnel plot, assessing the publication bias for studies containing data about the prevalence of retrocaval ureter

did not trim any studies, and Egger's regression intercept value was 0.09, with a two-tailed $p$ value of 0.95, implying no publication bias.

## Discussion

Our analysis confirmed a very low prevalence of this anatomical variant, which was found to be 0.13%, close to the 0.1% value given more or less empirically by other studies [6, 14, 23, 32].

Usually, the postrenal section of the inferior vena cava appears from the dorsal limb of the perimetanephric ring, which is made up from the subcardino-supracardinal anastomosis or sacrocardial vein and the lumbar segment of the supracardinal vein, rendering the right ureter to be located in front of the cava. However, if the inferior vena cava is formed from the ventral segment of the perimetanephric ring, which is usually formed from the anastomosis of the postcardinal vein (lumbar segment) and the anastomosis of the subcardinal and postcardinal veins, the right ureter will lay beneath the cava, thus leading to the appearance of the retrocaval ureter [2, 12] (Fig. 4).

There are two main types of retrocaval ureter: high loop (Type 1), in which the renal pelvis and the upper part of the ureter are nearly horizontal, causing the retrocaval ureter to be on the same level as the renal pelvis, with a reversed J appearance on the intravenous pyelogram and low loop (type II), in which the dilated upper ureter descends from the renal pelvis, then curves medially and upwards, generating an S-shaped appearance on the retrograde pyelogram [14, 30]. The first type is usually non-obstructive, while the second type often leads to obstruction [24]. No subtype analysis could be performed during our analysis, as the description of the cases usually lacked details about the subtype.

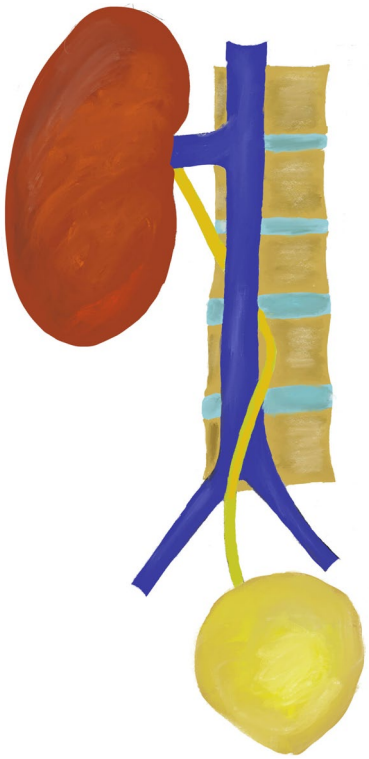

**Fig. 4** Retrocaval ureter

This condition seems to occur more often in men. For example, de Carlo, by reviewing all the cases published before him, found a male:female ratio of 17:6 [4]. Other authors give a ratio around 2.8 [25]. However, as de Carlo pointed out, this ratio could be caused by the increased number of men who were autopsied at the time [4], or a gender-based difference in addressability to physicians. We were unable to perform a proper, gender-based analysis of prevalence, due to the very low number of studies, and the very low prevalence of the variant.

From a clinical point of view, many cases of retrocaval ureter are silent, and detected incidentally using various imaging techniques. When present, the symptoms most often begin at the ages 30–40 and usually include: abdominal pain, hematuria, infection, and urolithiasis [29]. For example, Kimura found renal pain/colic to appear in most identified cases (70.7%), followed by urinary infection (23.5%), and hematuria (21.6%) [21]. Even though this condition is usually diagnosed in adult years, there has been an increased number of case reports in recent years showing symptomatic cases in children [29, 30]. For example, Sun et al., in a series of eight cases, having a median age of 9.2 years, found symptoms in five of them (three—right flank pain, one—gross hematuria, and one—urinary tract infection) [30].

The retrocaval ureter has been associated with other local or general congenital abnormalities, including horseshoe kidney, right double IVC, contralateral kidney agenesis, hypospadias, syndactilia, ventricular septal defect, preaortic venous confluence, the congenital absence of vas deferens, Turner syndrome or tracheoesophageal fistula with esophageal atresia. Retrocaval ureter is usually found on the right side; on the left side, it is extremely rare, and when identified it is usually associated with situs inversus, although isolated cases have been described in the scientific literature [32].

Some case reports have associated the presence of retrocaval ureter with urothelial cancers [3, 26, 27, 34]. Most likely, however, the association is purely incidental, the presence of a local tumor leading to the identification of the congenital ureteral abnormality.

Currently, surgery is the preferred therapeutic option for patients with symptomatic retrocaval ureter [31], even though there have been described cases in which a conservative management has been successful [35].

The surgical approach in symptomatic cases, usually involves ureteral division, the resection and relocation of the stenotic segment, and ureteroureteral or ureteropelvic reanastomosis [17]. Currently, the preferred method of treatment for symptomatic retrocaval ureter is represented by laparoscopic surgery, either transperitoneal (which was most often employed in published cases), or retroperitoneal [16]. If the retrocaval ureter has a normal appearance, it is usually preserved, but stenotic structures can be excised [16]. The main advantages of the transperitoneal laparoscopic approach include more working space, ease of transperitoneal suturing, decreased hemorrhage risk; more urologists are familiar with this approach, urine leak can be contained easier [8, 31]. The main advantages of the retroperitoneal laparoscopic approach include a decreased operating time (no need for mobilizing the colon or retracting the liver), and an easier access to the urinary tract [25].

## Limitations

A low number of relevant studies, associated with a scarcity of information presented in many studies included in our analysis, which did not allow us to perform gender/location/ethnic-based analyses.

In conclusion, the overall prevalence of retrocaval ureter is 0.13%. Even if this is obviously a rare condition, its presence must be suspected by practitioners, especially in the presence of urological symptoms without a clear cause.

**Author contributions** All authors participated equally in the design of the study, drafting the manuscript, and researching relevant information, and agreeing with the final version. The statistical analysis was conducted by SH and IN.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no competing interests.

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