# The Weigert-Meyer Law Demystified

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**Abstract**

**After reviewing the various hypotheses that have been put forward to attempt to explain the Weigert-Meyer Law, a new, simple, and attractive explanation, based on embryological facts, is offered (with illustrative drawings). We hope it will dissipate the mystery of the Weigert-Meyer Law.**

**Keywords: Weigert-Meyer Law.**

In a complete ureteral duplication, the ureter whose orifice is at a more medial and caudal site (known as the caudal[1] or the ectopic[2] ureter) reaches the upper renal moiety (or pyelon[3]). The other ureter, whose orifice is more lateral and cephalad (known as the cervical or upper[1] ureter or the orthoptic[2] ureter) reaches the lower renal moiety.

First Weigert (Carl or Karl Weigert, 1845-1904, German pathologist)[4] and later Meyer[1] recognized that this disposition is almost universal in cases of ureteral duplication. Hence, this has become known as the Weigert-Meyer Law. Only rare exceptions to this law have been observed. Four examples were collected from older literature, and seven were recently added.[5,6]

No one has reported seeing a double ureter developing in an embryo. However, two theoretical mechanisms for this development have been postulated. Either the two ureteral buds arise separately from the mesonephric duct, or a single bud arises from the mesonephric duct and then bifurcates at an early stage. Of these two possible mechanisms, the first seems to have been more widely accepted. For this study, we will take this as the mechanism of ureteral duplication, although either mechanism would fit within the framework of our explanation of the Weigert-Meyer Law.

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## Old Hypotheses

In earlier attempts to explain the Weigert-Meyer Law from an embryological point of view, conjectures have been made:

1. In the first hypothesis, the embryology of the ureter is said to be "so complicated that it appears a vain undertaking to make cause and effect understood ... an alienation which follows differentiation of cells during their division into two deviating types leading generally to separation .... It is not a satisfactory explanation to describe this reversion as a shifting of the Wolffian duct in passing by the ureteral orifice caudalward."[1]

2. A second hypothesis claims that the upper pole ureter "may be said to have undergone a developmental somersault."[7]

3. The third hypothesis surmises that the lower ureter reaches the bladder first and its orifice rises cranially and laterally. The superior ureter, on the other hand, reaches the bladder later and remains in a lower and more medial position.[8]

4. A fourth hypothesis reads: "The bud closest to the urogenital sinus will meet it earlier and start to twist around

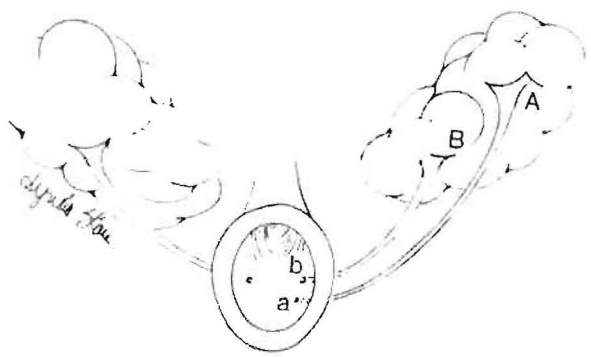


**Figure 1.** The left double ureter and kidney at 8-9 weeks schematically drawn after Pansky.[11]

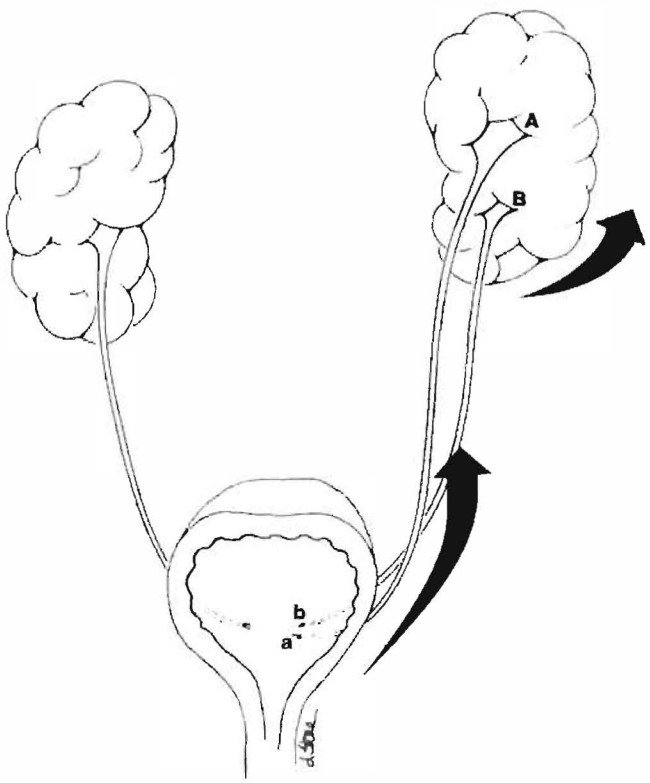


**Figure 2.** The embryonic kidney has ascended and the double ureters have crossed.

the unabsorbed segment of the common nephric duct. The second bud, being close to the first, will soon meet the urogenital sinus, too, and begin the same twisting migration. However, the ureteral bud (a) that joined the urogenital sinus first will always be ahead of the second bud (b). Because the bud (b), which initially was higher on the mesonephric duct, is now below the first bud, the two ureters have to cross. However, their relation to the nephrogenic cap will be governed by their respective position on the mesonephric duct, with the lower bud (a) draining the lower

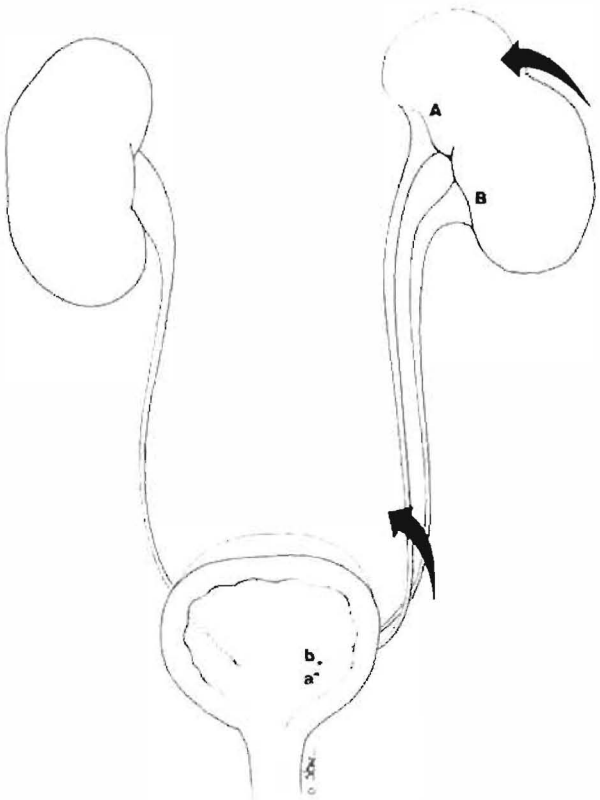


**Figure 3.** After birth, the kidney is in its adult position.

segment of the kidney and the upper bud (b) draining the upper part. As their lower ends are in reverse position, the higher bud, draining the upper part of the kidney, will open lower on the bladder base. The lower bud on the mesonephric duct is usually the one that meets the center of the nephrogenic cap, this drains most of the mass of the renal parenchyma."[9]

5. The fifth hypothesis contends that "the higher ureteral bud migrates with the mesonephric duct, rotating with it medially and then caudally, before it is attached adjacent, but distal to the lower pole orifice at the otherwise normal trigonal location."[10]

### A New and Simpler View

These five hypotheses are complicated, difficult to understand, and have never been proven. We propose a much simpler explanation based on the anatomical disposition of the kidney in its earliest embryonic development and on its subsequent well documented ascent and rotation (Figures 1-5).

After the ureter starts to bud and branch, at about the sixth week of embryonic life, it elicits a response from the nephrogenic cord (mass, blastema, or anlage), which starts to form the nephrons of the definitive kidney (metanephros). This process occurs at about the eighth week when the kidneys lie in a more caudal part of the embryo[11] in a V-shape (Figure 1). The upper moiety of the renal pole, lies

in a position lateral to the other pole[12] and is approached by the lower of the two ureteral buds. This is a natural consequence of the geometrical relationship between the duplicate ureteral buds and the renal anlage at this stage of embryonic development. Nature usually follows the most direct and shortest course. For the two ureters, this is to course parallel to one another rather than to cross over each other. If they cross, their combined length is longer than if they do not cross. The situation of Figure 1 is represented pictorially in Figure 5. This simple geometric argument indicates that it is very unlikely for the ureteral buds to cross before they reach the renal anlage.

The cornerstone of our explanation of the Weigert-Meyer Law is that the ureteral buds reach the renal anlage at a time when, unlike the adult kidney, it lies with its upper pole in a more lateral position than its lower pole, in an almost horizontal position (Figure 1). The two nephrogenic masses, right and left, form an obtuse angle that is concave and in the shape of a shallow "V." In the adult, on the other hand, the kidneys form an obtuse angle that is concave and facing down, like a circumflex (Figure 4).

To help illustrate some of the geometrical aspects of our explanation, we will first establish a coordinate system based in the kidneys. In abstract, each kidney can be viewed as having three principal axes: the first is the longitudinal axis, Ll, which runs through the center of the kidney from pole to pole; the second is the hilar axis, Hh; it is perpendicular to the first axis and passes through the hilum of the kidney; the third axis is the transverse axis, Tt; it is perpendicular to the first two and completes the orthogonal coordinate system.

As stated above, in the 8-week-old embryo, the longitudinal axes Ll of the two renal anlagen form a shallow V-shape. During embryonic growth and while the kidneys ascend, two renal rotations occur. The first is a rotation of approximately 90 degrees about the hilar axis, Hh. The second rotation, which occurs simultaneously with the first, is another rotation of 90 degrees; this time about the longitudinal axis, Ll. To aid in visualization, these two rotations have been represented as occurring sequentially in Figure 3. The net result is that in the adult kidneys, the longitudinal axes form a circumflex shape, while the hilar axes form a shallow V-shape.

During the rotational renal ascent, the double ureters will naturally cross (compare Figures 1 and 3 with Figure 4). Thus, another simple, geometrical argument suffices to explain the Weigert-Meyer Law.

When, by way of exception to the Weigert-Meyer Law, the two ureteral buds do cross in the embryo, before renal ascent and rotation, they will uncross during renal rotational ascent. This will result in the rare adult case that contradicts the Weigert-Meyer Law.

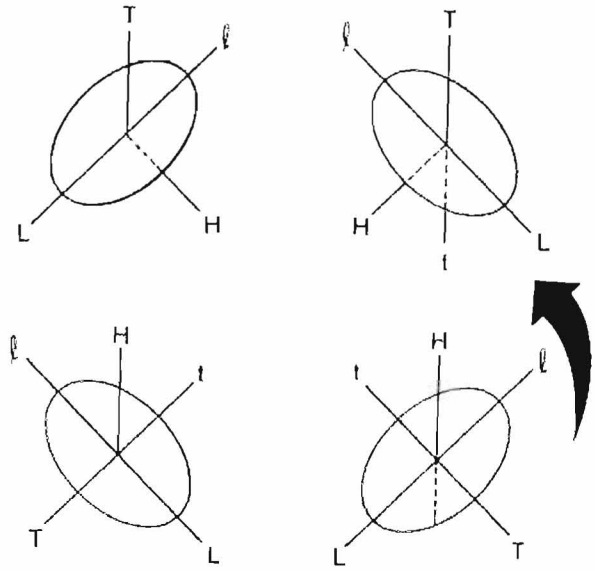


**Figure 4.** The right and left renal axes before and after renal rotational ascent.

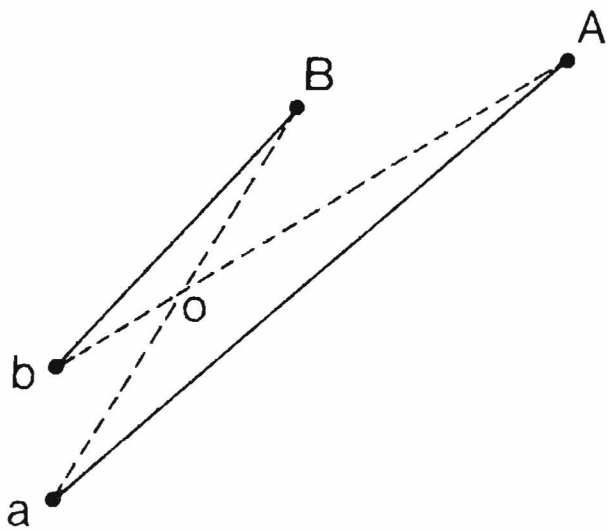


**Figure 5.** Parallel ureteral buds (bB and aA) are shorter than crossed ones (bA and aB).

## Conclusion

Our explanation is simple, rational, and it takes into account the relevant embryological and anatomical facts. It explains the relative position of the duplicate ureteral orifices in the bladder, the crossing of the duplicate ureters and the exceptions to the Weigert-Meyer Law, the mystery of which seems to have been finally dissipated.

We conjecture that previous theorists may have not fully recognized that the embryonic nephrogenic mass, at the time the ureteral buds approach it, lies in a position that is totally different from the position of the adult kidney.

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