Abnormal bilateral drainage of testicular veins: embryological aspects and surgical application

G. K. Paraskevas, O. Ioannidis, K. Natsis, S. Martoglou

Department of Anatomy, Medical Faculty, Aristotle University of Thessaloniki, Greece

Abstract
A combination of unusual bilateral drainage of the testicular veins observed in a male cadaver utilized for educational and research purposes is prescribed. In specific, the right testicular vein was terminated on the right renal vein at almost right angle, whereas the left testicular vein was bifurcated into a lateral component drained into the left renal vein and a medial component opened into the inferior vena cava close to its confluence with the left renal vein. Such a co-existence of bilateral testicular vein termination is very rarely presented in the literature. The main goal of this study is to provide an embryological development model for these variants and to highlight the likely occurrence of these anomalies to the surgeon of the region. The awareness of these venous anomalies can facilitate the surgeons in order to ligate properly and adequately the abnormal venous terminations and collaterals reducing that way the recurrence rate of varicocele.

Keywords: testicular veins, variants, drainage site, varicocele.

Introduction
The testicular veins as it is widely known display a great variability as regards their number, course and sites of termination. Specifically, Favorito LA et al. found that the variability of the right testicular vein referring to its number was 15%, with the relevant incidence on the left side being as high as 18% [1]. More prominent variability of testicular veins mostly regarding their number was observed by Asala S et al. (2001). These authors noticed that the variations, which were more common on the left side, were found in 21.3% of the specimens [2]. Their variable morphological and topographical features are not only significant during the surgical procedures undertaken in the retroperitoneal area, but also as during study taking part in cases of male infertility. The pathological dilated pampiniform plexus veins known as varicocele could be attributed to testicular veins variants. Varicocele appearing in approximately 15% of male population constitutes a specific pathological condition that could lead under certain circumstances to testis atrophy and reduce of fertility [3].

In the present work, a bilateral case of testicular vein abnormality is demonstrated in a male cadaver dissected during routine gross anatomy course. An effort has been made to elucidate the possible embryological model of development of such variants and to present the variable surgical aspects concerning the testicular veins anatomy.

Materials, Methods and Results
During routine dissection course taking place in our laboratory for the second year medical students, we came across an unusual bilateral drainage of the testicular veins in a 83-year-old Caucasian formalin-fixed male cadaver. The cause of death was not related to the detected venous anomalies. Past medical history indicated no pathological processes related to the urogenital system, no traumatic injuries of the region and no previous surgical interventions. By means of classic anatomical technique of human cadaver preparation, the anterior abdominal wall was resected and after removal of peritoneal organs and retroperitoneum, a more clear vision of the organs and vascular structures of the retroperitoneal region was provided. During detailed documentation of the precise morphology as well as topography of the vascular elements of the area, we observed, interestingly, the presence of anomalous termination sites of the testicular veins, bilaterally. In specific, we noticed on the right side the testicular vein exhibiting an ascending course and terminating at almost right angle on the right renal vein. On the contralateral side, the left testicular vein after coursing the retroperitoneal region obliquely and upwards, divided into two trunks, the lateral and the medial one. The lateral trunk drained into the ipsilateral renal vein prior to the hilus of left kidney at right angle, whereas the medial venous trunk terminated on the left aspect of the inferior vena cava, just 0.6 cm inferior to the drainage site of left renal vein (Figures 1 and 2). No concomitant anomalies of the inferior vena cava and the renal veins were noticed. The cadaveric findings and their anatomical relationship were documented by photos and a supplementary line drawing during the course of the anatomical dissection. The measurements were made with the assistance of a Vernier digital caliper with an accuracy of 0.1 mm.
The testicular vein originates from a plexus of multiple large veins, the so-called pampiniform plexus that after coursing across the spermatic cord at the level of the deep inguinal ring consists of two or three veins, united in a single vein at the level of the lumbar area [4]. The right testicular vein drains into the inferior vena cava in an oblique angle, whilst the left testicular vein ascends almost vertically terminating in the left renal vein in a right angle [5]. Regarding the variable number of testicular veins on each side, a duplicated right testicular vein is noticed in 4% [6] or in 15% of population [1], whereas a duplicated left testicular vein has been observed in 15% of specimens studied [1]. Three left testicular veins have been reported previously in the literature [7] with its incidence estimated at approximately 1% [8] or 2% [1], whilst even four left testicular veins have been observed with an incidence of 1% of the cases [1]. In some cases of duplicated veins, they showed a beaded appearance [2]. A great variability exists concerning the exact site of testicular vein termination. For the right testicular vein, various termination sites have been described except the typical site of inferior vena cava, such as the right renal vein with an incidence of 1% [1], 1.25% [2] or 5% [4], the confluence of the inferior vena cava and right renal vein [9], the accessory renal vein [2], the left margin of the inferior vena cava [7], the prerenal segment of the inferior vena cava [10], the lower portion of the inferior vena cava [11], the right subcostal vein [10, 12] or the common trunk constituted by the right renal and right testicular veins [4]. As concerns the left testicular vein, the sites of its termination may include, beyond its typical drainage site in the left renal vein, the inferior vena cava as demonstrated by Andreas Vesalius [13], the prerenal segment of the inferior vena cava [2], the accessory renal vein [2, 4], the left subcostal vein [12], the left eleventh posterior intercostal vein [14] or the left suprarenal vein [15]. The bilateral occurrence of testicular vein variations has been observed in 18.8% of cases [2]. The aforementioned authors classified testicular veins variations in four types, thus totally duplicated left veins (type 1), partially duplicated left veins (type 2), beaded bilateral veins (type 3), and high drainage into the inferior vena cava on the left and termination in the right renal vein on the right (type 4). Our case represents a combination of type 2 and 4 of Asala’s classification.

The testicular vein is derived from the subcardinal vein, with the anastomosis between subcardinal sinus and supracardinal veins being significant for testicular vein formation [16, 17]. Normally, the right testicular vein derives from the caudal portion of the right subcardinal vein that terminates in the subsubcardinal anastomosis [18], whereas the left testicular vein represents the caudal remnant of the left subcardinal vein [19]. In our case of bilateral venous abnormalities, we speculate that the drainage of the right testicular vein into the right renal vein is due to shift and migration of termination of the caudal segment of the right subcardinal vein to the right renal vein portion of subcardinal sinus. As for the medial component of the left testicular vein, we suggest that the shift of the left testicular vein to the left renal vein portion of subcardinal sinus associated with failure of the primary caudal portion of the left subcardinal vein to regress from its termination in the subsupracardinal anastomosis (Figure 3).

Drainage of a single or a supranumerary or a medial component of a single left testicular vein into the inferior vena cava is very rarely cited in the literature [2, 13], whereas right testicular vein termination on the ipsilateral renal vein has been reported with an incidence of 1–5% [1, 4]. After detailed research of the

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**Figure 1** - Photographic documentation of the bilateral testicular veins variations detected in our cadaveric specimen. RK: right kidney, LK: Left kidney, RRV: Right renal vein, LRV: Left renal vein, RTV: Right testicular vein, LTV: Left testicular vein, MT: Medial trunk, LT: Left trunk, RU: Right ureter, LU: Left ureter, IVC: Inferior vena cava, AA: Abdominal aorta.

**Figure 2** - Schematic line representation of the findings observed in the photograph of Figure 1. RK: Right kidney, LK: Left kidney, RRV: Right renal vein, LRV: Left renal vein, RTV: Right testicular vein, LTV: Left testicular vein, MT: Medial trunk, LT: Left trunk, IVC: Inferior vena cava, AA: Abdominal aorta.
literature, we were unable to detect such a combination of bilateral abnormal termination of the testicular veins. Andreas Vesalius, very early, in 1543, in his historical textbook of human anatomy entitled “De humani corporis fabrica”, described an almost similar variation, thus a case of bilateral incompletely double testicular veins with the right testicular vein terminated on the right renal vein and inferior vena cava and the left testicular vein terminated on the left renal vein and the lower portion of the inferior vena cava [13].

Figure 3 – (A) The primitive veins of the retroperitoneal area of an embryo at approximately eight weeks (modification from Arey LB, 1960 [18]). (B) Proposed drawing for development of the bilateral gonadal veins in the present case. 1: Postcardinal vein, 2: Supracardinal vein, 3: Subcardinal vein, 4: Prerenal portion of inferior vena cava derived from subcardinal vein, 5: Subcardinal sinus, 6: Renal portion of inferior vena cava from subsupracardinal anastomosis, 7: Postrenal portion of inferior vena cava from supracardinal vein, 8: Testicular vein, 9: Right renal vein anlage, 10: Right testicular vein, 11: Left renal vein anlage, 12: Lateral component of left testicular vein, 13: Medial component of left testicular vein, 14: Left testicular.

Varicocele can induce in up to 50% of patients semen disorders [20]. Varicocele can be treated by means of open or laparoscopic surgical ligation of the dilated testicular vein or by means of sclerotherapy [21]. It is important for the surgeon to bear in mind the likely presence of testicular vein variations regarding its number, site of termination and accessory anastomotic channels or collateral branches that should be ligated to exclude any varicocele recurrence [22]. Such a recurrence hazard has been estimated as high as 5–20% in patients suffering from varicocele [23]. Favorito LA et al. [1] observed collateral branches of the right testicular vein communicating with the colon in 21% of the cases; as for the left testicular vein, the incidence was 31%; in another study, such collateral veins were found in 74% of the cases [5]. The previous mentioned author noticed abdominal cross-communications between the right and left testicular vein in 55% of his material. These veins are ureteric veins that cross the midline and anastomose with the contralateral ureteric veins forming the so-called “testicular plexus” at the level of the fifth lumbar vertebra [6]. A not so uncommon sizeable venous trunk is the “nephrogenital vein” that crosses the outer renal border and joins the lateral division of the lateral testicular vein. In some cases, this vein communicates with colonic veins [6]. Such anastomoses with the peri-

renal drainage circle have been observed on the left in 45% and on the right in 37% of cases [24]. Furthermore, little veins presented close to the adventitia of the testicular artery could be responsible for varicocele recurrence. Therefore, it has been suggested that the additional ligation of the testicular artery decreases the recurrence rate after varicocele surgery [25].

Conclusions

During pre-operative planning of varicocele, the surgeon might not overlook the possibility of an abnormal drainage site or an accessory collateral branch as it occurs in our case, because such a misdiagnosis and improper surgical estimation could result in an increase of varicocele recurrence rate. Moreover, the awareness of such testicular vein variability should be obtained by the radiologist during interpretation of abdominal angiographies findings, especially those found in spermatic venographies.

References

Corresponding author
George K. Paraskevas, Assistant Professor, MD, PhD, Department of Anatomy, Medical Faculty, Aristotle University of Thessaloniki, P.O. Box 300, 54124 Thessaloniki, Greece; Phone +302310999330, Fax +302310999330, e-mail: g_paraskevas@yahoo.gr

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