The submediastinal venous plexus of the adult human testis

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SUMMARY

The venous drainage of the human testis consists of two oppositely oriented currents towards and away from the mediastinum testis. These centrifugal and centripetal currents have been known and studied since the nineteenth century. Based on our own observations of 35 human testes prepared by the technique of serial cleared thick sections oriented in three axial body planes, we describe a submediastinal venous plexus, located on the deep surface of the mediastinum, receiving its tributaries from within the parenchyma and giving off collaterals to form the pampiniform plexus. We propose the name coronary submediastinal venous plexus owing to its most characteristic disposition.

Key words: Testis – Man – Veins – Submediastinal plexus

INTRODUCTION

It has long been known that the human testicular parenchyma is drained by two venous sets of opposite direction centrifugal and centripetal to the testicular mediastinum. The centrifugal veins drain towards the periphery of the testis away from the centrally located mediastinum. This group eventually flows into the larger superficial veins of the testis, and these into the origin of the pampiniform plexus. In contrast, the centripetal group flows to the deep mediastinum testis, converging to form vessels of increasing size, and finish by helping create the pampiniform plexus.

The bipolarity in the venous drainage was described early as the late nineteenth century. Bimar (1888) described two venous contingents, one flowing towards the albuginea and the other to the mediastinum; Hill (1909) called them the ascending and descending veins, in accordance with his own classification of the arterial vessels. It was Harrison and Barclay (1948) who first used the centrifugal versus centripetal nomenclature adopted by us. Hundeiker and Keller (1963) and Hundeiker (1971), although using the terms peripheral and central veins for this dichotomy, perfectly described the course these vessels take from their origin until the formation of the pampiniform plexus. More recently, several authors (Kormano and Suoranta, 1971; Suzuki and Nagano, 1986; Gaudin et al., 1988) have provided excellent descriptions of the testicular venous drainage, dividing the centripetal veins into two groups, anterior and posterior, draining the corresponding parts of the testis (Gaudin et al., 1988).

There is therefore considerable evidence for the existence of these two contingents regarding their localisation and contribution to the formation of the venous drainage of the testis. However, a detailed description of the possible existence of anastomotic connections between the centripetal veins, or the formation of a venous plexus does not exist.

Our work aims at studying the centripetal venous drainage of the human testis, in order to provide a detailed description and also to clarify the existence of anastomoses between these vessels. We describe here, for the first time, the existence of a venous plexus in the deep mediastinum, formed by the convergence of the centripetal veins and draining to the pampiniform plexus.

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Materials and methods

Serial sagittal/horizontal and cross sections of 35 adult human testes, obtained from autopsy specimens, were previously injected via the testicular artery, testicular vein, or both, with a colloidal suspension of barium sulphate, commercial gelatin and coloured pigment, and afterwards cleared by a modified version of Spalteholz technique (Goyri-O'Neill, 1984; Goyri-O'Neill et al., 1982; Pais, 1987). All testes were obtained from cadavers devoid of testicular and vascular pathology. In order to characterize the vessels found in the cleared sections, we measured vessel calibre using a stereoscopic optical microscope equipped with an ocular lens fitted with a micrometric ruler.

Histological sections coloured by several methods (hematoxylin-eosin, Masson trichrome-aniline blue, Mallory-aniline blue, Mallory-Azan, Van Gieson and Veroheff) and microvascular casts studied by scanning electron microscopy (SEM) were used to study normal morphology of the parenchyma and vessels, and to study the microvasculature.

Results

Apart from converging to form larger vessels beneath the mediastinum testis, we have observed that the centripetal testicular veins anastomose with each other abundantly, and almost invariably, enabling us to describe a submediastinal venous plexus, to which all the centripetal veins drain and from which several collectors arise that finally contribute to the origin of the pampiniform plexus.

	Affluents	Plexus	Effluents
N	200	50	25
Mean	138.86	199.00	253.95
SD	67.40	94.20	129.24
Max.	400	464	592
Min.	24	80	80

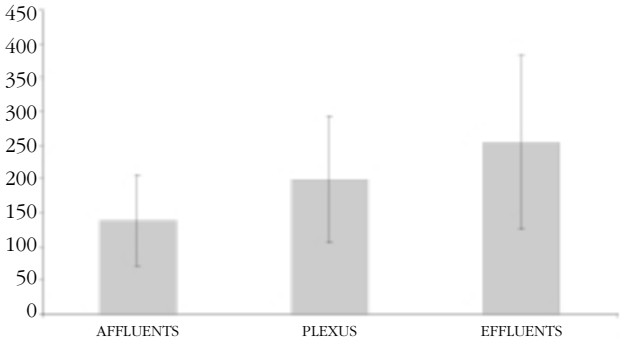

Figure 1.- Vein measurements in the three portions of the plexus: number of measurements (n), mean value, standard deviation (SD), maximal (Max.) and minimal (Min.) values are given. All values except (n) in µm.

This plexus is divided into three portions: the plexus proper, its tributaries (affluents) and collectors (effluents). Measurements were taken of the vascular calibres of all veins in each of the portions of the plexus considered (Fig. 1). The tributaries of the submediastinal venous plexus are the previously described centripetal veins of the testis (central or ascending), which converge to the deep portion of the mediastinum testis, coursing inside the upper extremity of the testicular septa or, rarely, in the thickness of the apex of the testicular lobules (Fig. 2). To better characterize these vessels, we made a total of 200 measurements in thick cleared sections. The affluent calibre ranged widely between 24 and 400 µm. The majority of these vessels (170/200-85.00%) had a measured calibre of under 200 µm, therefore belonging to the microvascular network (Esperança-Pina, 1980). Of these, 105/200 were first-order venules (101-200 µm), 63/200 were second-order venules (31-100 µm), and only 2/200 (1%) were post-capillary venules (11-30 µm). The 30 remaining vessels (15%), having a measured calibre of over 200 µm, can be classified as small-calibre veins. All these affluents begin to approach one another as the deep mediastinum is approached, frequently joining and forming larger vessels, and finally ending in the plexus itself.

The plexus proper is formed by vessels located at the deep surface of the mediastinum testis, running either parallel, obliquely, or at right angles to the main axis of the testicle (Fig. 2). To ascertain the calibre of these vessels, 50 random measurements were taken in several cleared sections. The results obtained by this method revealed that these vessels are usually of large calibre, between 80 and 464 µm, with a mean value of 199 µm just inside the defining limit for microvascularisation. Of these, only 4/50 (8%) were second-order venules; the majority (29/50-58%) were first-order venules, the remaining 17 (34%) being small calibre veins. The vessels that constitute the plexus proper, together with their tributary vessels come together and form convergence-type anastomoses among one another. More rarely, they may also form anastomoses of the oblique type, conferring a structural uniformity to this formation by uniting distinct segments of the plexus. This disposition is particularly well evidenced in the thick cleared cross sections of the testis, and was confirmed by the microvascular corrosion casts observed with SEM (Fig. 2C). This latter technique also permitted us to observe the unevenness of the vessels' contour, reflected in significant variations in their calibre during their relatively short length (Fig. 2).

The collecting veins drain the plexus proper towards the origin of the pampiniform plexus, located in the testicular hilum (Fig. 2). These are usually large calibre veins, as can be confirmed

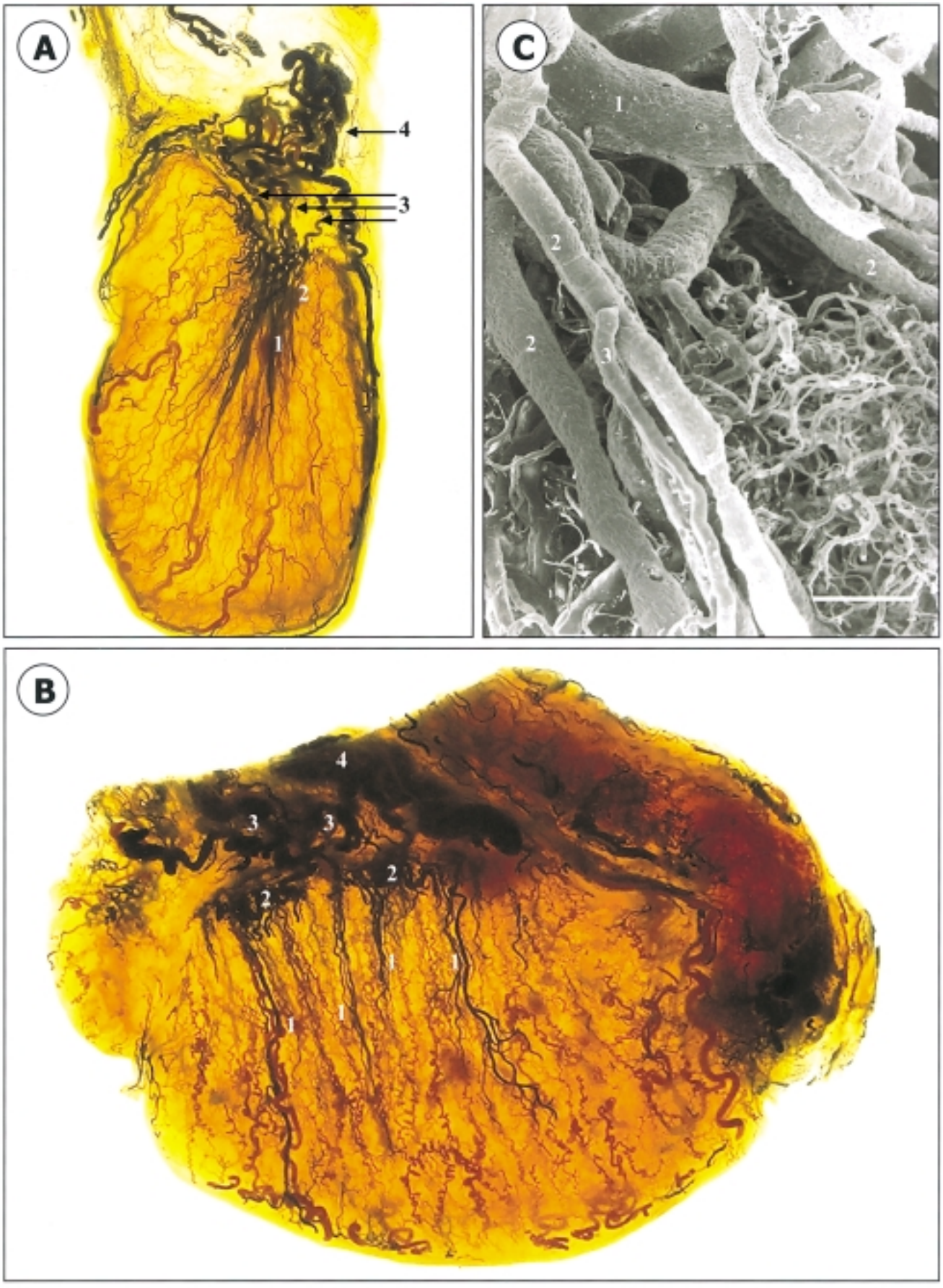

Figure 2.- Human testicular submediastinal venous plexus: Cleared cross (**A**) and sagittal (**B**) sections of adult human testis showing the submediastinal venous plexus and its three parts: affluents (1), plexus proper (2) and collecting veins (3). The origin of the pampiniform plexus can also be seen (4). SEM of microvascular corrosion cast (**C**) showing the plexus proper (1) and several septal affluents: first-order venules (2) and second-order venule (3) (Scale bar=500 μm).

by the 25 random measurements made in thick cleared sections. The mean calibre of these vessels was 253.95 µm, and their maximum value 592 µm. In fact, in this small sample, 12 out of 25 vessels (48%) had a calibre over 200 µm; 12/25 were first-order venules and only 1 vessel had a calibre under 100 µm (second-order venule). As regards their course, these effluent vessels had two distinct dispositions: they either arose from the periphery of the plexus, coursed towards the tunica vasculosa and finished by anastomosing (via a convergence-type anastomosis) with the testicular superficial veins, themselves affluents of the pampiniform plexus, or they coursed directly towards the hilum, traversing the mediastinum and finishing directly at the origin of the pampiniform plexus.

Discussion

The bipolarity of the venous drainage of the human testis is well established and has been described by many authors (Bimar, 1888; Hill, 1909; Harrison and Barclay, 1948; Hundeiker and Keller, 1963; Hundeiker, 1971). The existence of a centrifugal and centripetal venous drainage has been confirmed using a variety of techniques, such as angiography, gross dissection, and SEM. We consider that these are not the best methods for studying this region; in our opinion the technique best suited for the characterization of the venous drainage in the vicinity of the mediastinum testis is the use of serial cleared sections, obtained in the three major planes of the body. In this study, we consistently observed a closed venous structure in the deep mediastinum, formed by several anastomoses of large calibre vessels (whose mean calibre bordered on the boundary for microvascularisation) to which smaller calibre venules, located in the deep parenchyma flow, and from which arise several large calibre veins, eventually ending in the origin of the pampiniform plexus, located in the testicular hilum. Given the reproducibility of our findings, and since we could find no mention of it in the existing literature, we propose to name this previously unknown structure the "submediastinal venous plexus of the human testis".

Considering the ensemble of the three components of this plexus in cross section, the submediastinal venous plexus describes a concavity, encompassing the deep surface of the rete testis, and receiving, on its convex side, the centripetal affluent veins. The collecting veins arise from the periphery and connect it to the origin of the pampiniform plexus. Thus, the submediastinal plexus assumes the form of an inverted crown, leading us to add the designation of "coronary submediastinal venous plexus of the human testis" for this structure.

This disposition is not, however, altogether perfect, as can be seen from the observations made in thick cleared sagital sections. The mediastinum testis is elongated in the sagittal plane, and therefore the plexus itself is likewise elongated. Moreover, in this orientation, the plexus appears to be constituted by zones of greater and lesser vascular density, united by intervening sections. This explains why the plexus is seen to be irregular in serial cross sections, with a paucity of vessels in some sections, contrasting with the exuberant crown-like disposition in others. We feel that this does not invalidate the proposed denomination of coronary venous plexus, since it refers to the most striking morphological aspect exhibited by this structure.

In conclusion, we have found that in the deep centripetal venous system of the human testis there is a constant plexus-like disposition of veins, as regards the deep surface of the mediastinum, which receive parenchymal venules of lesser calibre and emit larger collecting veins towards the origin of the pampiniform plexus, either directly through the substance of the mediastinum, or via an anastomosis with the superficial testicular system. We propose to call this hitherto undescribed structure the "coronary submediastinal venous plexus of the human testis".

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