THE EVALUATION OF SAPHENOFEMORAL INSUFFICIENCY IN PRIMARY ADULT VARICOCELE

Thesis

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by

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Mohamed Ahmed Khalil

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List of Abbreviations

ASRM	American society for reproductive medicine
BMI	Body Mass Index
CI	Confidence Index
CDUS	Coloured Doppler ultrasonography
CVI	Chronic venous insufficiency
IBM	International Business Machines
MDA	Malondialdehyde
MHz	Mega Hertz
ROS	Reactive oxygen species
RR	Relative risk
SFJ	Saphenofemoral junction
SPSS	Statistical program for social society
T10	Thoracic 10
TAC	The total antioxidant capacity
t-PA	Tissue type plasminogen activator

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1. Introduction

Varicocele, the most common surgically correctible cause of male infertility, is characterized as abnormal tortuosity and dilation of the pampiniform plexus within the spermatic cord **(French et al., 2008)**. It is found in approximately 15% of the general population, 35% of men with primary infertility and 80% of men with secondary infertility **(Jarow, 2001)**.

Although the exact etiology of varicocele is not known, the pathogenesis may be associated with various factors resulting in increased retrograde blood flow or increased pressure in the pampiniform plexus and internal spermatic vein **(Graif et al., 2000; Schneck and Bellinger, 2007)**. Possible mechanisms are the absence or incompetence of the venous valves, venous collaterals and increased venous pressure of renal vein **(Schneck and Bellinger, 2007)**. Moreover, some studies in the literature have shown that varicocele may be associated with underlying arterial and venous pathological conditions **(Bilgili et al., 2003; Yetkin et al., 2005)**.

Varicocele is associated with impaired spermatogenesis and a duration dependent decrease in testicular function **(Jarow, 2001)**. Impairement in spermatogenesis, which is mainly in the form of low or absent count, decreased sperm motility and abnormal sperm morphology, can be observed in infertile males presenting with varicocele **(Paduch and Niedzielski, 1996)**.

The relationship between varicocele and testicular volume has been studied by many authors and generally they concluded that varicocele is associated with testicular hypotrophy. Due to the detrimental effects of varicocele on the fertility, a prompt diagnosis and management are essential in the majority of the cases **(Sigman and Jarow, 1997; Sakamoto and Ogawa, 2008)**.

A previous study demonstrated that a left varicocele may be bilateral disease caused by incompetence of the one-way valves in the internal spermatic veins, associated with persistent pathological hydrostatic pressure in the long vertical spermatic veins and venous bypasses **(Gat et al., 2005)**. Another study by **Yetkin et al., (2005),** has demonstrated that patients with coronary artery ectasia had an increased prevelance of varicocele compared with patients with coronary artery disease. Also, the increased prevalence of peripheral varicose veins has been reported with coronary artery ectasia by **Androulakis et al., (2004)**. **Kilic et al., (2007)** reported that varicocele is associated with an increased prevalence of peripheral varicose veins. Moreover, previous studies have shown a relationship between varicocele and valvular incompetence of the sapheno-femoral junction, which contributes to the formation of peripheral varicose veins **(Ciaccio et al., 1995; Bilgili et al., 2003**). **Sakamoto and Ogawa (2008)** concluded that varicoceles, especially bilateral varicoceles, may be associated with underlying venous abnormalities.

Aim of the work

The aim of this study is to evaluate the possible relationship between varicocele and sapheno-femoral insufficiency in patients diagnosed with primary varicocele.

2.1. Varicocele

2.1.1. Anatomical consideration

2.1.1.1. Anatomy of the scrotum

The scrotum is a cutaneous and fibromuscular sac containing the testes and the lower parts of the spermatic cords, and dependent below the pubic symphysis in front of the upper parts of the thighs. It is divided on its surface into right and left halves by a cutaneous ridge, or raphe, which is continued anteriorly to the inferior surface of the penis, and dorsally along the middle line of the perineum to the anus. The left side usually descends a little more than the right side, in correspondence with the greater length of the left spermatic cord. The external appearance varies in different circumstances, thus, under the influence of warmth, and in old and debilitated persons, the scrotum is smooth, elongated and flaccid, but, under the influence of cold, and in the young, it is short, corrugated, and closely applied to the testes. It consists of the skin and the dartos muscle, together with the external spermatic, cremastric and internal spermatic fascia. The inner surface of the internal spermatic fascia is loosely attached to the parietal layer of the tunica vagainalis ***(Sinnatamby, 1999)***.

The scrotal skin is very thin, of a brownish colour, and often thrown into folds or rugae. It is covered with thin scattered hair, the roots of which are visibile through the skin and is provided with sebaceous glands, the secretion of which has a peculiar odour. It also contains numerous sweat glands, pigment cells, and nerve ending responding to mechanical stimulation of the hair and skin, and to variations in the circumambient temperature. Subcutaneous adipose tissue is lacking ***(Sinnatamby, 1999)***.

The dartos muscle is a thin layer of nonstriated muscular fibers, continuous around the base of the scrotum with the superficial fascia of the groin and of the perineum. It sends inwards a sagittal septum of the scrotum. The scrotal septum is composed of all the layers of the scrotal wall, except the skin, which forms one continuous investment to the entire scrotum. The dartos muscle is closely untied to the skin, but is connected with the subjacent parts by delicate areolar tissue, by means of which it is able to move with great independence ***(Richard et al., 2005)***.

2.1.1.2. Anatomy of the testis

The testis is a paired, ovoid male reproductive organ that sits in the scrotum, separated from its mate by a scrotal septum. Described by some as being shaped and sized like a large olive or small plum, the average volume of the adult testis is approximately 25 ml. Typically, it measures 3.5-5 cm in length by 2.5-3 cm in both width by 3cm in depth (antero-posterior diameter) ***(Snell, 2000)***.

Smooth to palpation, the testis sits obliquely with its long axis mostly vertical with a slight anterior and lateral slant to the superior pole. Superiorly, it is suspended by the spermatic cord, with the left testis often sitting lower than the right testis. Inferiorly, the testis is anchored to the scrotum by the scrotal ligament, a remnant of the gubernaculum ***(Swartz, 2006).***

The tunica vaginalis testis (a remnant of the processus vaginalis) envelopes the testis in a double layer, except at the superior and posterior borders where the spermatic cord and epididymis adhere to the testes ***(Tintinalli et al., 2004)***.

The visceral layer of the tunica vaginalis testis is closely applied to the testis, epididymis, and ductus deferens. On the posterolateral surface of the testis, this layer invests a slit-like recess between the body of the epididymis and the testis that is called the sinus of epididymis. The parietal layer of tunica vaginalis is adjacent to the internal spermatic fascia, is more extensive, and extends superiorly into the distal part of the spermatic cord. Deep to the tunica vaginalis, the tunica albuginea is a tough, fibrous outer covering of the testis. On the posterior surface, it is reflected inwardly to form an incomplete vertical septum called the mediastinum testis. The mediastinum testis extends from the superior to near the inferior portion of the gland. It narrows in width as it travels inferiorly. Anteriorly and laterally, numerous imperfect septa are given off, which radiate to the glands surface and are attached to the tunica albuginea. These divide the interior of the testis into numerous, cone-shaped spaces that have a wide base at the gland's surface and narrow as they converge to the mediastinum. In these spaces, the numerous lobules of glandular structures (the minute but long and highly coiled seminiferous tubules) are housed. The mediastinum supports the ducts and vessels as they pass to and from the glandular substance. The seminiferous tubules are lined with germ cells that produce sperm and nutrient fluid. These tubules empty their contents into a network of anastomosing ducts, which ultimately empties into the epididymis ***(Moore and Daley, 2006)*** (Fig. 2.1.1).

2.1.1.3. Vascular system

The right and left testicular arteries, branches of the abdominal aorta, arise just distal to the renal arteries and provide the primary vascular supply to the testes. They enter the spermatic cord at the deep inguinal ring and continue along the posterior surface of the

testis, penetrating the tunica albuginea where the capsular arteries form and course through the tunica vasculosa, located beneath the tunica albuginea. Centripetal branches arising from the capsular arteries carry blood toward the mediastinum, where they divide to form the recurrent rami that carry blood away from the mediastinum into the testis. A transmediastinal arterial branch of the testicular artery is present in approximately one-half of normal testes. It courses through the mediastinum to supply the capsular arteries and is usually accompanied by a large vein. The deferential artery, a branch of the superior vesicle artery, and the cremasteric artery, a branch of the inferior epigastric artery, supply the epididymis, vas deferens, and peritesticular tissue ***(Middleton and Bell, 1993)***.

The arteries supplying the scrotum are: the external pudendal branches of the femoral artery, the scrotal branches of the internal pudendal artery, the cremastric branch from the inferior epigastric artery (***Sinnatamby, 1999)***. The number and locations of anastomoses vary between the testicular artery and its branches and between the artery to the vas deferens and the cremasteric artery. Branches of the pudendal artery supply the scrotal wall ***(Tumeh et al., 1991)***.

Venous drainage is via the pampiniform plexus of draining veins, which is formed around the upper half of the epididymis in a variable fashion and continues as the testicular vein through the deep inguinal ring. The right testicular vein empties into the inferior vena cava, and the left testicular vein empties into the left renal vein ***(Tumeh et al., 1991)***.

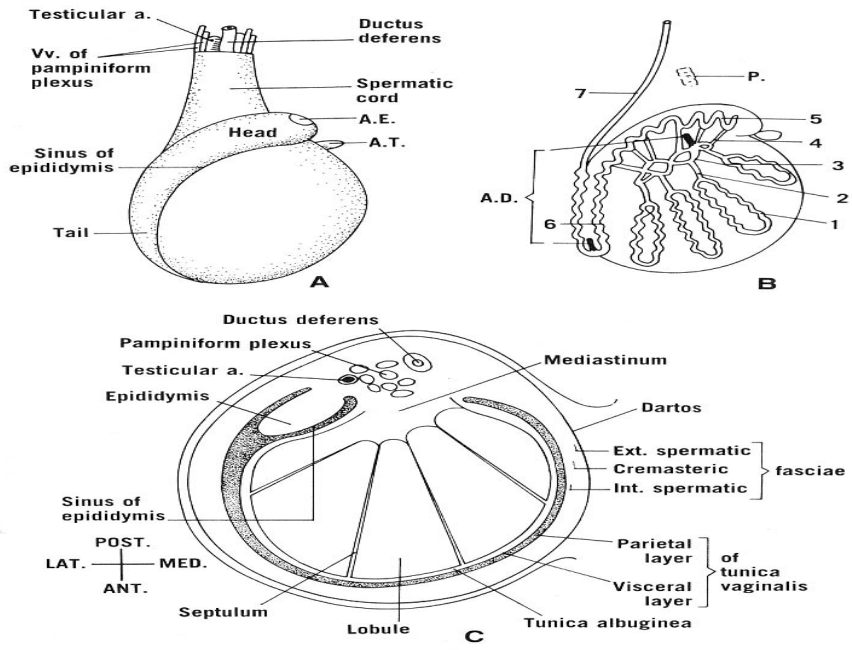

Fig 2.1.1: The testis and epididymis. A, Right testis, lateral aspect. B, Ductal system. C, Horizontal section, showing the tunica vaginalis. The numbers 1 to 7 refer to the parts (1) convoluted seminiferous tubules, (2) straight seminiferous tubules, (3) rete testis, (4) efferent ductules of testis, (5) lobules (or cones) of epididymis, (6) duct of epididymis, (7) ductus deferens ***(O'Rahilly et al.,* 2008)**.

2.1.1.4. Lymphatic drainage

The lymph vessels end in the inguinal lymph nodes ***(Sinnatamby, 1999)***.

2.1.1.5. Anatomy of the spermatic cord and fasciomuscular tube

When the testis descends through the abdominal wall into the scrotum, it carries its vessels and nerves and the deferent duct with it. These structures meet at the deep inguinal ring and together form the spermatic cord, which suspends the testis in the scrotum, and extends from the deep inguinal ring to the posterior border of the testis. The left spermatic cord is a little longer than the right. The spermatic cord traverses the inguinal canal having the walls of the canal as its relations and with the ilio-inguinal nerve inferior to it. On passing through the canal it acquires coverings from the layers of the abdominal wall. These coverings extend downwards into the wall of the scrotum and are named, the internal spermatic, cremastric, and external spermatic fascia ***(Poirier and Charpy, 2000)***.

The internal spermatic fascia is a thin layer which loosely invests the spermatic cord, and is derived from the transversalis fascia. The cremastric fascia of a number of muscular fascicule, united to one another by areolar tissue. The muscular fasciculi constitute the cremasteric and are continous with the abdominal internal oblique. The external spermatic fascia is a thin fibrous stratum continous superiorly with the aponeurosis of the abdominal external oblique, and descending from the crura of the superficial ring ***(Sinnatamby, 1999)***.

2.1.1.6. Structure of the spermatic cord

The spermatic cord is composed of arteries, veins, lymph vessels, nerves and the vas deferens, connected together by areolar tissue ***(Sinnatamby, 1999)*** *(Fig.2.1.2.)*.

2.1.1.6.1. Arteries of the spermatic cord

Testicular arteries are two long, slender, vessels arise from the front of the aorta a little below the renal arteries. Each passes obliquely downwards and laterally behind the peritoneum, on the psoas major. Each passes in front of the genitofemoral nerve, the ureter and lower part of the external iliac artery to reach the deep inguinal ring, where it enters the spermatic cord. With the other constituents of the spermatic cord it traverses the inguinal canal and enters the scrotum. At the upper end of the posterior aspect of the testis it divides into two branches which pass on to the medial and lateral surfaces, pierce the tunica albugenia and end on the tunica vasculosa. From the latter, terminal branches pass into the substance of the testis at various points over the free surface. In the inguinal canal, it gives one or two twigs to the cremaster muscle. Cremasteric artery is a branch of the inferior epigastric artery which accompanies the spermatic cord, supplies cremaster and other coverings of the cord, and anastomoses with the testicular artery. Deferential artery (artery of the vas deferens) arises from the superior vesical artery and accompanies the ductus in the course to the testis where it anastomoses with the testicular artery. At the level of the testis three arteries anastomose to allow adequate blood supply even with division of the testicular artery (***Parrot and Hewatt, 1994; Mellinger, 1995***).

2.1.1.6.2. Testicular veins

The testis is immediately drained by a surrounding network of tortuous veins, the pampiniform plexus. The veins of the pampiniform plexus unite to form the origin of the internal spermatic vein immediately above the testis. The left internal spermatic vein terminates in the inferior surface of the left renal vein. In the presence of duplicated left renal veins, the internal