Recent Advances in Radical Prostatectomy

Essay

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Introduction

Prostate cancer (PC) is the fourth most common male malignant neoplasm worldwide. Its incidence varies widely between countries and ethnic populations, being the lowest in Asia (particularly in China) and the highest in North America and Scandinavia, especially among African Americans **(Quinn and Babb, 2002).** It is the most common visceral malignant neoplasm in U.S. men accounting for one third of all such cancers **(Jemal et al, 2004).**

The PC field has been growing over the past two decades since the introduction and widespread use of prostate-specific antigen (PSA) as a screening test**.** This rise in the number of cases diagnosed with PC necessitated refinements of existing therapies and the development of novel approaches **(Scales et al, 2008)**.

Radical prostatectomy is the “gold standard” treatment for a localized disease providing the best outcomes in both cancer control and quality of life by means of reducing metastatic progression and cancer-related death **(Holmberg et al, 2002).** The operative goals, in order of importance, are cancer control, maintaining urinary continence, and preservation of sexual function.

Technically, the open surgical approach to radical prostatectomy is one of the most difficult operations in the field of urology which necessitates great skills and experience in selection of surgical candidates and operative techniques. Although effective as a technique for curing PC, radical retropubic prostatectomy (RRP) was fraught with significant morbidity including excessive blood loss, urinary incontinence, and impotence **(Reiner and Walsh, 1979).** Recently, the open surgical approach has been challenged by advocates of refined surgical skills, laparoscopic and robotic techniques.

Several detailed anatomic studies provided important insights into the periprostatic anatomy, especially that of the dorsal venous complex, neurovascular bundle **(Walsh and Donker, 1982)**, and striated urethral sphincter **(Oelrich, 1980)**. These landmark observations led to a significant reduction in operative morbidity. As a result, the anatomic nerve-sparing radical retropubic prostatectomy has remained the cornerstone of surgical treatment for clinically localized PC **(Reiner and Walsh, 1979).**

In an effort to further decrease the morbidity of open prostatectomy, laparoscopic radical prostatectomy (LRP) was described as a minimally invasive surgical approach for treating PC **(Schuessler et al, 1997).** The preliminary results of the previous study showed that LRP offered no significant advantage over open surgery although the cancer cure with LRP was deemed comparable to its open surgical counterpart. As such, LRP was not widely adopted into the field of urology **(Schuessler et al, 1997).**

By the 20th century, advances in task-specific surgical instrumentation, optics, digital video equipment, as well as computer and robotic technology opened a new frontier for minimally invasive laparoscopic prostatectomy. These advances led urologists to revisit LRP with encouraging surgical outcomes **(Guillonneau and Vallancien, 2000; Abbou et al, 2001).**

The recent introduction of advanced robotic devices such as the daVinci Surgical System (Intuitive Surgical, Inc., Sunnyvale, CA) to the field of urologic surgery has added new hopes of reducing operative times and the learning curve for minimally invasive prostatectomy (**Menon et al, 2002).** By incorporating sophisticated wristed technology at the terminal ends of the robotic instruments, a surgeon is able to operate, suture, and dissect with the facility of a human wrist. In addition, the superior three-dimensional view offered by this robotic system provides the surgeon with an unprecedented view of the periprostatic anatomy **(Trabulsi et al, 2010).**

Aim of the work

In this study, we will highlight the recent evolutions in RRP in addition to the advances in both laparoscopic and robotic-assisted laparoscopic radical prostatectomy (RALP) and present the currently available data on oncologic as well as functional outcomes with these techniques.

Surgical Anatomy of the Prostate

The prostate is a fibromuscular and glandular ‘encapsulated’ organ which lies deep in the pelvis and its shape resembles an inverted cone or chestnut. The average volume in a young man is approximately 20 ml with dimensions of 3 cm (apex to base), 2.5 cm (A-P distance) and 4 cm (maximum transverse diameter) **(Fornage, 2006)**.

It is fixed superiorly to the bladder and inferiorly by the external urinary sphincter and membranous urethra. The apex refers to its inferior limit, and the base is the most posterior and superior portion of the gland **(Romanes, 1996)**.

Relations of the Prostate

The prostate is a truncated cone, with its base at the urethro-vesical junction, its apex at the urogenital diaphragm and has four surfaces (anterior, posterior and two infero-lateral) **(Tanagho, 1992**).

The anterior surface:

It is relatively narrow and convex extending from the apex to the base. It lies about 2 cm behind the pubic symphysis, separated form it by a rich plexus of veins and some loose adipose tissue. Near its upper limit, it is connected to the pubic bone by the pubo-prostatic ligaments.The urethra emerges from this surface antero-superior to the apex (**McNeal, 1988*).***

The posterior surface: (figure 1-1)

The flat posterior surface is separated from the rectum by Denonvilliers’ (rectovesical) fascia and is palpable on rectal examination. Denonvilliers’ fascia lies between the anterior rectal wall and the posterior surface of the prostate and seminal vesicles. It extends laterally to the fascia surrounding the neurovascular bundles (NVBs). This strong fascial layer is said to be derived from two layers of pelvic fascia which have fused, although microscopically this is not always evident **(Jewett et al, 2003)** Denonvilliers' fascia appears to act as a barrier against the posterior spread of prostate cancer. Posterosuperior to the prostate lie the seminal vesicles and ampullae of the vasa deferentia **(Romanes, 1996)**.

Near its superior border is a depression when the two ejaculatory ducts penetrate the gland, dividing this surface into a superior and an inferior larger part. The superior part is variable in size and usually regarded as the external aspect of the median lobe.The inferior part shows a median sulcus,usually considered to mark a partial separation into right and left lobes,forming the main prostatic mass and continuous behind the urethra (**McNeal, 1988*).***

The infero-lateral surfaces:

The inferolateral surfaces are convex in shape and related to the medial edges of levator ani muscles and their overlying fascial layer (endopelvic fascia), the prostate capsule is separated from the levator fascia by arteries and nerves continuing to the corpora cavernosa and also supplying the prostate **(Walsh et al, 1983)**.

The apex:

It projects inferiorly between the medial borders of the two levator ani muscles, rest on the superior fascia of the urogenital diaphragm which is continuous with the fascial sheath of the prostate and in contact with the fascia on the superior aspect of the external urethral sphincter and transverse perinea profundi muscles: figure **(1-1) (Tanagho, 1992**).

The base:

It is largely continuous with the neck of the bladder above it.The urethra enters this surface nearer to its anterior border to traverse the substance of the prostate and emerges a little anterior-superior to the prostate. Crainially and posteriorly, the bases of the seminal vesicles rest against the base of the prostate (**Tanagho, 1992**).

The base of the prostate is intimately related to the bladder, in continuity with the urethra and detrusor muscle. The circular smooth muscle of the bladder neck may extend into the prostate as far as the level of the verumontanum and is known as the preprostatic sphincter (**Myers, 2002)**.

The prostate is traversed by the ejaculatory ducts and the urethra. The ejaculatory ducts are paired structures, formed by the conjunction of the vas deferens and the duct of the seminal vesicle. They enter the prostate on the upper part of the posterior surface and travel inferomedially within the gland. They enter the prostatic urethra on the colliculus (verumontanum), either side of the prostatic utricle. The opening has no sphincter mechanism, and lies approximately at the midpoint of the prostatic urethra.

The prostatic urethra, itself, begins at the bladder neck and ends as it passes through the pelvic floor to become the membranous urethra. It is approximately 3 cm long and travels in a convex curve to exit the prostate anterosuperiorly to the apex. The verumontanum is the largest part of the urethral crest, present only in the prostatic urethra **(Romanes, 1996)**.

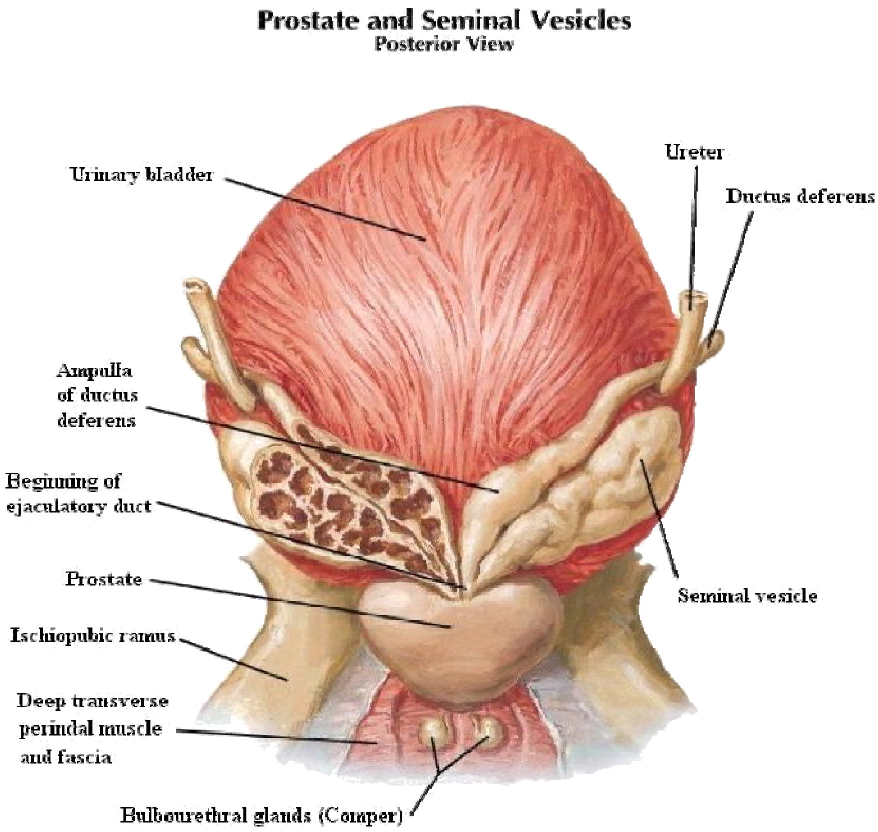

Figure (1-1) Prostate (posterior view) **(flocks, 2007)**

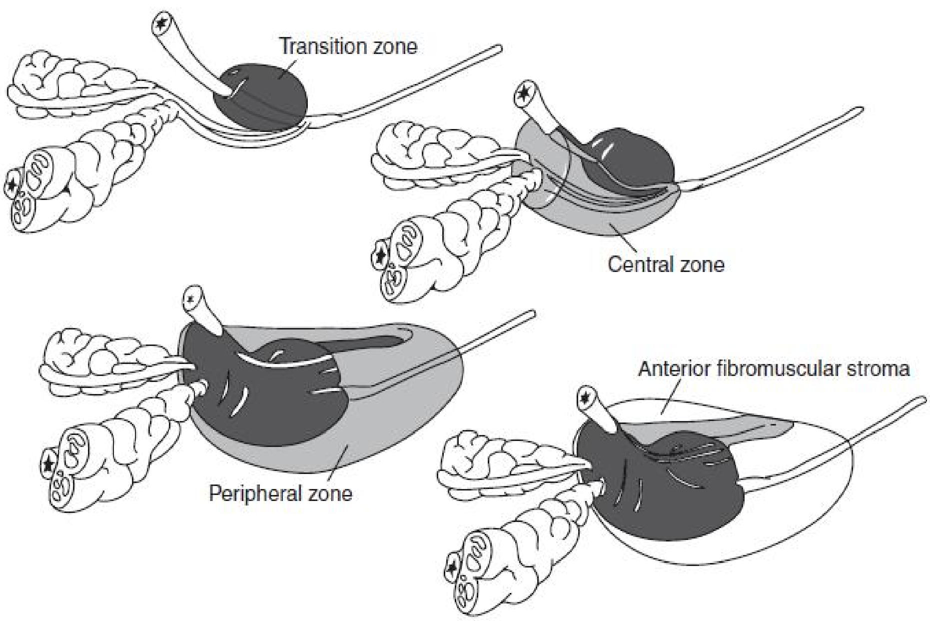

Figure (1-2) Zonal anatomy of the prostate **(McNeal, 1981)**.

Zonal anatomy of the Prostate (Figure 1-2)

There have been many attempts to define intraprostatic anatomy. The earliest 'modern' anatomical description was by **(Lowsley, 1995)**, He described five lobes, a posterior, two lateral, an anterior, and a middle lobe, based on human fetal studies. This arrangement appeared to fit with clinical findings but could not be demonstrated in normal adult prostate.

(McNeal, 1968) proposed the now-accepted classification of zonal anatomy based on microscopic gland and duct structure. The anterior fibromuscular stroma contains no glandular tissue and can account for one third of normal prostatic weight. The peripheral zone (70%) is the only palpable part of the prostate and extends from the apex posterolaterally to the base. The central zone (25%) is wedge shaped, with its base at the bladder neck and apex at the prostatic utricle. Both the central and peripheral zones attach to the anterior fibromuscular stroma.

Increased gland volume with age is predominantly due to increased transition (5-10%) and periurethral (<1%) gland volume resulting from benign prostatic hyperplasia (BPH). The clinical significance of zonal anatomy also relates to distinctions in the pathogenesis of prostatic disease, with adenocarcinomas most commonly developing in the peripheral zone **(McNeal, 1981)**.

Cystoscopic anatomy

Although cystoscopy does not assess the whole of the prostate gland, some conclusions regarding gland anatomy can be made. The position of the external sphincter can be identified by an inward bulging of the urethral mucosa. A more definitive landmark is the verumontanum and this forms the distal limit for transurethral resection of the prostate (TURP) or bladder neck/ prostatic incision. However, even this landmark can vary in its relation to the sphincter. Proximal to the verumontanum is the prostatic utricle, from which point the urethra angles upward, normally this is 35°. The so-called ‘lateral lobes’ refer to endoscopic appearances and represent BPH of the transition zone. The ‘median lobe’ represents hyperplasia of the periurethral glands **(McNeal, 1981)**.

***The prostatic* capsule proper:**

The fibro-muscular stroma of the prostate is directly continuous with fibro-muscular element of the gland itself which in turn is directly continuous with muscular element of the smooth musculature of the bladder neck. The fibro-muscular stroma of the prostate condenses on the periphery of the gland to form a thin, dense and fibrous capsule proper (**Tanagho, 1992**).

The Prostatic Sheath and attachments:

The Prostatic Sheath is considered to be a reflection from the endopelvic fascia. It surrounds the prostate and its capsule proper. It is made up primarily of fibrous tissue in which a rich plexus of veins is embedded . Inferioly, it blends with the fascia on the deep surface of the sphincter urethrae, the deep transversus perineal muscles and with perineal body. Anteriorly, the sheath is continuous with the pubo-prostatic ligament which is a vascular fibro-elastic condensation, containing some smooth muscle. It extends from the back of the bodies of the pubic bones close to the median plane to be attached to the anterior surface of the fibrous sheath of the prostate and the neck of the bladder (**Romanes, 1977**).

Posteriorly, the sheath is fused with the obliterated recto-vesical peritoneal pouch. In male foetuses at the fourth month, the recto-vesical peritoneal pouch descends to the pelvic floor separating the prostate from the rectum later these layers fuse together to form a dense layer known as fascia of Denonvilliers separating the rectum from the prostate, the seminal vesicle and the base of the bladder and the prostate is well fixed in its place due to its apex rests on the superior aspect of the genitourinary diaphragm and is attached to the back of the pubic bone by pubo-prostatic ligaments . It is firmly adherent to the base of the bladder superiorly and confined within the prostatic sheath which is a reflection from the endopelvic fascia, it is well supported posteriorly by the obliterated peritoneal pouch forming the Denonvilliers fascia **(Myers, 1994).**

The arterial Supply:

The principal arterial supply to the prostate derives from the inferior vesical branch of the anterior division of the internal iliac artery **(Figure 1-3)**. Smaller contributions are given by the middle rectal and pudendal branches of the internal iliac. The inferior vesical artery is the second branch from the anterior division and originates near the upper margin of the greater sciatic notch. It travels forward to the bladder base, which it also supplies. It also sends branches to the seminal vesicles, including a relatively constant branch to the tip of the seminal vesicle that has some significance during radical prostatectomy. It then divides into urethral and prostatic branch groupings. The urethral branches penetrate the prostate substance at the prostatovesical junction posterolaterally. These then travel perpendicular to the urethra and approach the bladder neck mainly at the 5 and 7 o'clock positions **(Romanes, 1996; brooks, 1998)**.

These vessels then course parallel to the urethra and are named the arteries of Flocks **(flocks, 2007)**. These supply the urethra, the transition zone, and the periurethral glands, and are responsible for arterial bleeding during TURP. The capsular branch of the prostatic artery runs posterolaterally between the levator fascia and prostatic fascia. It is accompanied by the cavernous nerves and contributes to the NVB of Walsh referred to in radical retropubic prostatectomy (**Walsh, 1998)**.

From this position, the NVB approaches the prostatic apex, where it lies behind the membranous urethra. The NVB may be connected to the prostatic apex by fine vascular branches, and neural elements are particularly at risk of damage during dissection of the prostatic apex (**Walsh, 1998)**.

The capsular branch gives perpendicular branches that penetrate the capsule to supply the glandular tissue and terminate by supplying the pelvic floor with small vessels.

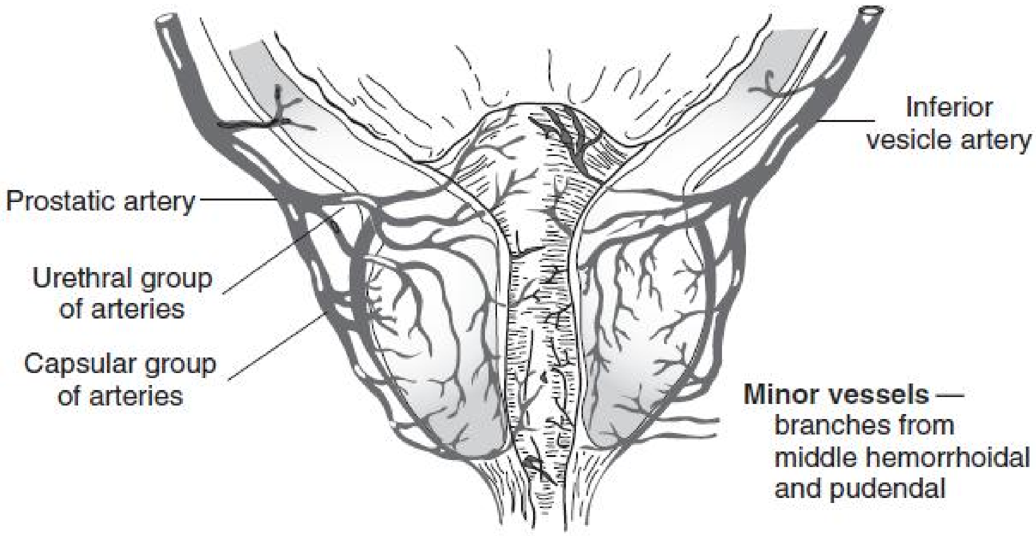

Figure (1-3) Prostatic arterial supply and its divisions **(Flocks, 2007)**

The Venous Drainage:

Venous drainage from the prostate is into Santorini's plexus. Santorini's plexus is the extremely variable venous network draining the penis and prostate. From the deep dorsal vein of the penis there are three branches. One is superficial and runs within adipose tissue anterior to the prostate. This forms the median longitudinal vein divided when approaching the prostate within the retropubic space at radical prostatectomy or Millin prostatectomy. The other two branches are deep to the fascia and form lateral plexuses which communicate with venous plexuses around the bladder, rectum, and emissary veins of the pelvic bones.

(Batson, 1996) proposed these as the reason for preferential metastatic spread to the pelvic skeleton. Santorini's plexus drains to vesical and pudendal veins and finally to internal iliac veins. Bleeding from venous injury during surgical