PROSTATIC EVALUATION BY TRANSRECTAL SONOGRAPY AND ULTRASONICALLY GUIDED PROSTATIC BIOPSY

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SUMMARY

Transrectal sonography opens up new dimensions in the diagnosis of prostate pathology and is a powerful tool for early detection and evaluation of prostatic cancer. Both longitudinal and transverse ultrasound imaging of the prostate are possible with different scanning systems. These two scanning methods yield complimentary information about the gland. A new biplane probe combines these two methods on a single probe and gives multiplanar scanning facility.

Transrectal sonography system's facilities include dynamic imaging, accurate puncture guidance, both transperineally and transrectally, and precise distance and volume determinations.

Key Words: Transrectal Sonography, Prostatic Biopsy.

INTRODUCTION

Transrectal ultrasonography has been a routine method for prostatic lesions in the Radiology Department of Marmara University Hospital since December 1985. A new ultrasonographic equipment, with rotating sector and longitudinal scanning facilities, has been purchased in September 1988, and a prospective study of the efficiency and diagnostic accuracy of this new method in prostate cancers has been planned. This article is an introduction to this study, which will be followed by a second publication providing the clinical results.

The prostate is a major cancer site for which effective surgery exists but where cancer is usually undetected until it is too advanced to be cured and only palliative surgery is available then. Prostatic cancer, providing it has not penetrated the capsule or invaded the seminal vesicles, has an excellent cure rate when treated by radiotheraphy or surgery.

Currently the only detection technique for prostate cancer at the curable stage is rectal palpation. Only a minority of carcinomas of the prostate are discovered by this technique. When transuretral resection of the prostate (TURP) specimens are analysed, about 13 % are found to have cancer.

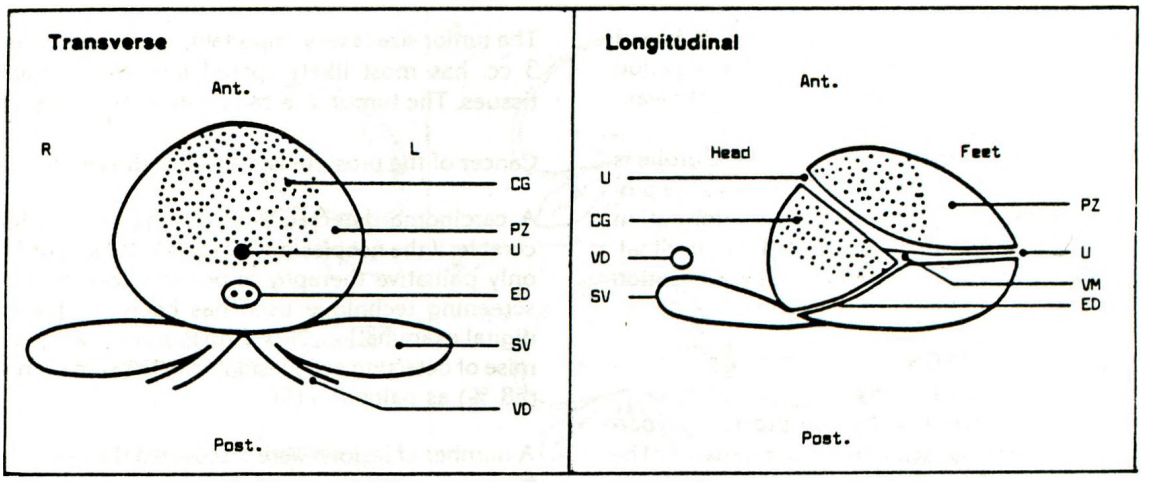
During the past few years a revolution has occured in prostatic highresolution ultrasound.

The prostate can be visualized using conventional transabdominal ultrasound equipment. When scanning suprapubically, the bladder is used as an acustic window, this approach allows for rough volume determination.

Scientific research (1,2) indicates that longitudinal and transverse ultrasound imaging of the prostate gives complementary information about the gland, and transrectal scanning allows for the visualization of the different anatomical regions of the prostate, as well as the prostatic capsule and also about the tissue surrounding the glad, including the seminal vesicles.

ANATOMY

For many years, the prostate was described as divided into a series of lobes. The concept was that these were selectively involed by a benign prostatic hypertrophy. McNeal has shown that such lobes do not exist (3). The prostate is divided into 2 major components; a central gland (CG) or internal zone, which consists of periurethral glands draining into the urethra, surrounding by a Peripheral zone (PZ) or external zone of glands draining into verumontanum (VM). (Fig. 1).



CG - Central Gland (Internal Zone)
PZ - Peripheral Zone (External Zone)
U - Urethra
ED - Ejaculatory Duct
SV - Seminal Vesicles
VD - Vas Deferens
VM - Verumontanum

Fig. 1.The normal anatomy of the prostate

Magnetic Resonans Imaging (MRI) studies confirm that, there is a true difference in structure between the central gland and peripheral zones, even before the development of benign prostatic hyperplasia (BPH).

Posteriorly the seminal vesicles converse at the base and the vasa deferens, run close together in the midline and continue inside the posterior PZ as the two ejaculatory ducts.

At the inferior end of the prostate, known as the apex, lies the urogenital diaphragm, which can sometimes be made out as an echopenic curvilinear structure. At the posterior of the prostate lies a sheath of fascia known as Denonvilier's fascia. Superior to the prostate lies the bladder, and anterior to the prostate are a series of vascular structures that lie directly posterior to the pubic symphisis. Superior to the prostate and posterior to the badder are the seminal vesicles, which arise from the peripheral zone. Usually it is hard to differentiate the peripheral zone from seminal vesicles but often the texture within the seminal vesicle is more echopenic than that of the peripheral zone.

EQUIPMENT

Many different ultrasonographic scanning probes are available, but the major types are summarized in three groups.

a) Transverse (axial) scanning:
These type of probes produce transverse scans of the prostate. The probes consist of a motor unit and a rotating rod, on which a rectal tube and a transducer are mounted. The transducer is covered by a rubber sheath, which is filled with water through the rectal tube. Generally 7 MHz transducer is used for high resolution imaging and 4 MHz transducer for deep penetration. During scanning the transducer rotates, producing circular sectional images perpendicular to the longitudinal axis of the probe. In transverse scan, images of the lateral lobes of the prostate ar well visualized and the symmetry of the gland is easly evaluated.

b) Longitudinal scanning:
These probes can be both linear or sector type. New sector type probes give better images. The transducer consists of a motor unit and gives real-time sectional images. In longitudinal scans the base and apex of the gland are well defined, as is the urethra.

c) Bi-plane scanning:
It is the ideal system, which is just beginning to be available; in which both transverse and longitudinally oriented transducer are found in the same transducer handle (4).

It is clearly advantageous to be able to avoid a second rectal insertion. The use of such rectal probes requires that a condom filled with water be placed around the transducer, so that there is a good contact between the transducer and the rectal mucosa.

PROCEDURE

The patient is examined in either the left lateral decubitus or the lithotomy position. A rectal palpation is made to ensure that the lumen of rectum is clear.

First the prostate is scanned transversely, the probe is gently moved in and out of the rectum to scan the prostate from base to apex. When sufficient information has been obtained the gland is scanned longitudinally. The transducer is rotated for optimal visualisation from the base of the gland to the apex.

PATHOLOGIC FINDINGS

Benign Prostatic Hypertrophy

The appearances seen with benign prostatic hypertrophy on a transrectal scan are rather variable. The most common finding is a gland that is markedly enlarged with a smooth outline and overall organomegaly and with a texture slightly more coarsely echogenic than the normal.

It is uncommon to see focal enlargement of one segment of the prostate that bulges into the bladder or towards the rectum. The involvement of the CG may be heterogeneous so one may see both echopenic and echogenic areas as a consequence of BPH, that differential diagnosis of cancer can be difficult.

The adenoma develops in the CG, as the adenoma expands, the PZ becomes compressed and it does not extend into the PZ. The major application of transrectal ultrasound (TRUS) in cases of BPH is the determination of the size of the gland, in order to plan the surgical procedure.

Volume Determination

The volume of the prospate is calculated by two different methods. The first method is calculation of the volume by using the formula for a prolate elipse. The width X length X height of the prostate is calculated either from transabdominal or transrectal views and multiplied by 0,5233. Several authors found an accuracy of $\mp$ 10 % by this method. The second way is the determination of the overall area of a series of equally spaced, parallel cross sections of the gland from base to apex. In each image the prostate is outlined using the joy-stick or the light-pen and the computer calculates the volume of the gland.

Carcer of the prostate

Autopsy and surgical studies have shown that the PZ is where almost all cancers of the prostate start. Approximately 80 % of neoplasms develop in the PZ, and their differentiation is high when they are small (5). Neoplasms can be visualized by TRUS. They appear as hypoechoic areas in the normally hyperechoic PZ. As the tumor increases in size it may invade the CG. This becomes apparent in the scan image as an echopoor expansion into the CG or as a non-visualization of the borderline between the CG and PZ.

The tumor size is very important, as a tumor exceeding 3 cc. has most likely spread into the surrounding tissues. The tumor size can be determined by TRUS.

Cancer of the prostate is staged as shown in figure 2.

A carcinoma detected at the stage A or B level is curable; if the neoplasm has reached stage C or D level, only palliative theraphy is possible. So far the only screening technique used has been the transrectal digital examination. New ultrasound shows good promise of detecting early lesions with the same sensitivity (58 %) as palpation (6).

A number of lesions were discovered that were not felt by rectal palpation; those over 1 cm in diameter were biopsied percutaneously using a guidance system attached to the ultrasound transducer. About 50 % of these lesions were shown to be neoplasms.

PROSTATE BIOPSY GUIDED BY TRUS

Biopsies of the prostate gland can be performed using either the transperineal or the transrectal approach.

Biopsy with the transverse scanning probe

For transperineal biopsy the patient is placed in either the lithotomy or the left decubitus position. The perineum is prepared for puncture and anaesthetized. The probe is inserted into the rectum and the target for puncture is located.

A puncture line is superimposed onto the image, the position of the probe is adjusted until the puncture line transects the target. The biopsy is taken in the usual way. As the needle transects the scanning plane its position is seen as a bright echo on the image.

Biopsy with the longitudinal scanning probe

With this transducer both transperineal and transrectal biopsies are possible. Transperineal biopsy is taken as explained above.

For transrectal biopsy, the probe is inserted into the rectum, and the position of the transducer is adjusted until the puncture line, superimposed on the image, transects the target of biopsy. The biopsy is taken in the usual way. The tip of the needle is visualized as penetrates the rectal wall and enters the prostate. Transrectal biopsies are performed without anaesthetics and well tolerated by most patients.

The transperineal approach is favoured by many doctors because of minimal risk of infection. The drawbacks of this approach are the relatively long puncture path and the fact that patient may experience some discomfort. The procedure is time-consuming because of the need for local anaesthetics and preparation of the skin.

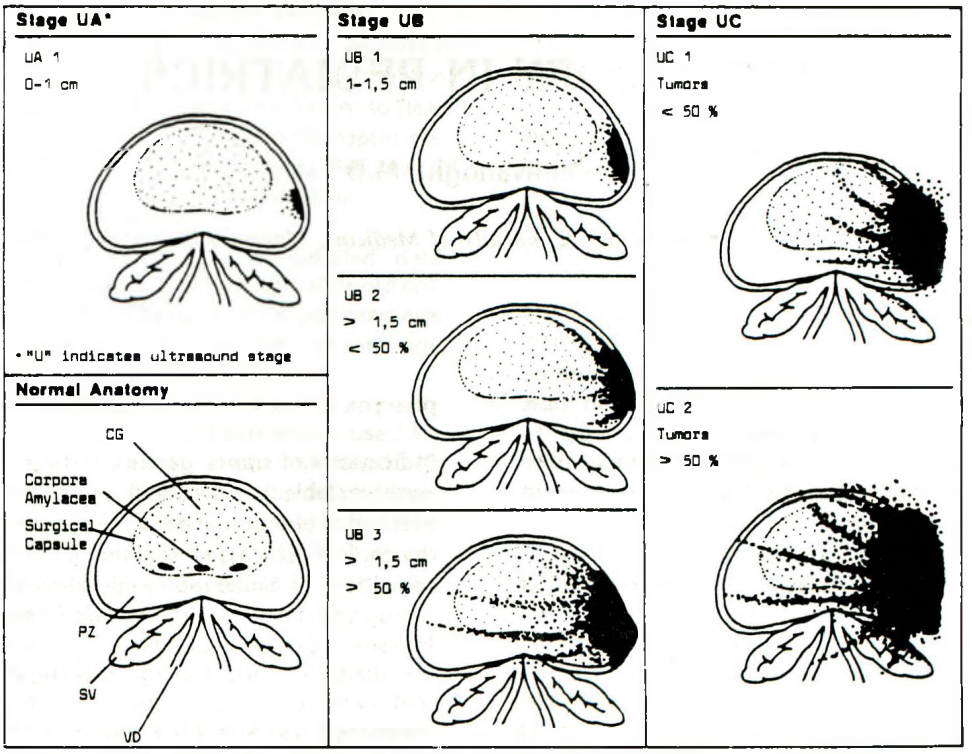


Fig. 2. A proposed ultrasound staging system of prostate cancer

Stage A 1 : Small focus of neoplasm incidentally discovered on TURP

Stage A 2 : Widespread infiltration of the prostate at TURP

Stage B 1 : Small nodule without capsular invasion

Stage B 2 : Larger nodule within the capsule

Stage C : Capsule of the prostate or seminal vesicles have been invaded

Stage D : Metastases to other parts of the body

Many doctors prefer transrectal approach because of a short puncture path, minimal discomfort experienced by the patients, and less time-consuming than transperineal biopsy. Theoretically there is a greater risk of infection by this way, as the needle may be contaminated by rectal contents. However some authors have shown that the infection risk is not higher than the perineal approach.

CONCLUSION

With transrectal ultrasound it is possible to obtain high-resolution images of the prostate gland, both in the horizontal plane and the sagittal plane.

Cancers of the prostate can be accurately measured, inabling definite staging possible. Because of the high-resolution images even small cancers (1 cc) can be diagnosed and early detection of non-palpable lesions is thus possible.

The needle tip is visualized during the biopsy. This ultrasonic needle guidance facility also makes transperineal radioactive seed implantation into prostatic cancers possible (2).

Accurate volume determination of the prostate is possible with transverse scanning. This is important in the surgical planning of benign prostatic hyperplasia and in the monitoring of radiation treatment of prostate cancer.

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