Role of transrectal ultrasound in the diagnosis of extracapsular prostate cancer

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Abstract

Introduction Transrectal ultrasound (TRUS) has significantly improved the diagnostic rate, nevertheless, the correlation between findings on TRUS and clinically significant prostate cancer (PCa) is not completely understood. The purpose of this study was to evaluate the diagnostic accuracy and utility of preoperative TRUS in patients with PCa to define the sonographic signs of cohesion of the Denonvilliers' fascia (DF) to prostate capsula (PC) to detect the local advancement of the disease.

Methods Between April 2010 and May 2013, at our Department of Urology, the clinical anatomy of preoperative regions and excised specimens was reviewed macroscopically for 68 cases of radical retropubic prostatectomy for PCa and compared to ultrasound images obtained by TRUS.

Results Pathological analysis detected on the surface of the prostate the DF fused with the PC at the midpoint of the prostatic posterior surface in 94 % of the cases, in 4 % the DF remained at a certain distance from PC in this region and in 1 case lateral pelvic fascia fused with PC and little adipose tissue was present between them ($P < 0.005$). The TRUS allowed a more precise result in terms of tumor extension to DF with a detection rate of 95 %. ($P < 0.001$).

Conclusion In our opinion, it is very important to recognize preoperatively the possibility of cancer extracapsular extension to the DF and to the rectum wall, using a simple and low cost examination as TRUS. The knowledge of the fascial structures anatomy around the prostate is necessary to perform a nerve-sparing radical

prostatectomy, avoiding excessive bleeding, iatrogenic positive surgical margin, and post-operative complications.

Keywords Transrectal ultrasound · Prostate cancer · Denonvilliers' fascia · Prostatic capsule

Riassunto

Introduzione L'ecografia prostatica transrettale (TRUS) ha migliorato significativamente il tasso di diagnosi, tuttavia la correlazione tra i risultati della TRUS e il cancro prostatico clinicamente significativo non sono completamente noti. Lo scopo di questo studio è stato quello di valutare l'accuratezza diagnostica e l'utilità preoperatoria della TRUS in pazienti affetti da carcinoma prostatico (PCa) allo scopo di definire i segni ecografici di coesione della fascia di Denonvilliers (DF) alla capsula prostatica (PC) e rilevarne lo stato di avanzamento locale di malattia.

Metodi Tra l'aprile 2010 ed il maggio 2013, presso il nostro Dipartimento di Urologia, sono stati studiati 68 pazienti sottoposti a prostatectomia radicale per PCa. In questi pazienti è stata valutata l'anatomia patologica dei pezzi operatori confrontandola con le immagini ecografiche ottenute alla TRUS preoperatoriamente.

Risultati Dall'analisi isto-patologica dei campioni si è ottenuto che nel 94 % dei casi la DF rimaneva adesa alla PC in una zona centrale della superficie posteriore della ghiandola prostatica, mentre nel 4 % la DF rimaneva ad una certa distanza dal PC; solo in un caso la fascia laterale pelvica rimaneva coesa alla PC con presenza di scarso tessuto adiposo tra entrambi ($P < 0.005$). La TRUS ha permesso di ottenere un quadro molto preciso in termini di estensione del tumore alla DF con un tasso di rilevamento del 95 %. ($P < 0.001$).

Conclusioni A nostro parere è molto importante riconoscere preoperatoriamente la possibilità di estensione

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extracapsulare della malattia tumorale alla DF e/o alla parete del retto con un esame semplice ed economico come la TRUS. La conoscenza anatomica delle strutture fasciali intorno alla prostata è necessaria per eseguire una prostatectomia radicale nerve-sparing, evitando un eccessivo sanguinamento, la positività iatrogena dei margini chirurgici e le complicanze post-operatorie.

Introduction

Radical prostatectomy (RP) is the main option in the treatment of clinically localized prostate cancer (PCa) [1]. However, urologists not occasionally encounter intra-operative excessive bleeding, iatrogenic positive surgical margin, and post-operative complications [2].

Impotence is a common side effect of this intervention with a high impact on the patient's quality of life [3]. Nerve-sparing (NS) surgery aims to preserve neurovascular bundles localized close and laterally to the prostate.

The knowledge of the fascial structures anatomy around the prostate, such as: prostatic fascia (PF), prostatic capsule (PC) and Denonvilliers' fascia (DF) is necessary to perform a nerve-sparing radical prostatectomy (NSRP) and the prevention of operative complications [4].

Advances in the anatomical elucidation of the prostate and surgical techniques have contributed to accurate procedures of RP and excellent survival [5]. However, in literature exists many disagreements regarding the description of these anatomical structures [6].

The prostate "capsule" does not exist. Rather, the fibromuscular band surrounding the prostate forms an integral part of the gland. The prostate is surrounded by fascial structures: anterior/anterolaterally by the PF and posteriorly by the DF [7].

Conventional (gray-scale) transrectal ultrasound (TRUS) does not detect PCa with adequate reliability and, therefore, cannot replace systematic biopsies; it represents only the current standard method in guiding prostate biopsies [8].

Although TRUS has significantly improved the diagnostic rate, the correlation between findings on TRUS and clinically significant PCa is not completely understood [9].

The purpose of this study was to evaluate the diagnostic accuracy and utility of preoperative TRUS in patients with PCa to define the sonographic signs of cohesion of the DF to profile of the prostate gland to detect the local advancement of the disease.

Materials and methods

Between April 2010 and May 2013, at our Department of Urology, the excised surgical specimens were reviewed

macroscopically for 68 cases of radical retropubic prostatectomy for PCa and compared to ultrasound images obtained by transrectal gray-scale (B-mode) prior to RP. After ultrasound, all cases examined had a strong suspicion of extracapsular disease invasion in the DF. None of the selected cases received any pre-surgical treatment such as radiation or hormonal therapy. Before the operation we informed each patient about the indications, contents and complications, including urinary incontinence and erectile dysfunction, and we received a written consent back. The operations were performed by three experienced operators. The histological analysis was performed by two pathologists. Prostatectomy specimens were step sectioned and processed according to a standard protocol. Postoperatively, the localisation of suspicious areas in prostate imaging was compared to the pathology results.

Conventional (gray-scale) TRUS was performed using a Logic 7 (General Electric) ultrasound device, equipped with 9–4 MHz convex end-fire probe.

Patients were examined in the left lateral position with legs flexed; the probe was inserted into the patients' rectum so that it was possible to reflect the bladder and prostate through the rectal wall, providing a sagittal and transverse image from any angle.

The specific sonographic sign in defining the extent of extracapsular disease was given by the characteristic image of traction in the rectal wall to the DF, causing a sign of reverb ultrasound at posterior surface of prostate, when the probe is retracted from the rectum (Fig. 1).

A Chi-square test was used to compare histological evaluation of RP cases and transrectal gray-scale ultrasound.

P value less than 0.05 was considered statistically significant.

Results

We prospectively examined 68 patients with PCa prior to open RP and classified as suspicious for extracapsular disease in conventional gray-scale ultrasound.

The median preoperative PSA was 7.35 ng/ml. The mean age at surgery was 66.2 years old. The median prostate size measured 41.8 ml, with a range 28–87 ml, and the average Gleason score was 6.8. Of the 68 patients with PCa who had ultrasound extracapsular signs, 24 men had a Gleason score of 7 or more ($P < 0.001$).

Digital rectal examination suspicious for extracapsular disease was detected in 88 % (60/68) of patients. The detailed results of the patient's characteristics and pathologic findings of PCa are described according to Gleason scores in Table 1. Histological tumor detection was most prominent with location of positive surgical margins in the

Fig. 1 **a** TRUS image in midline transverse plane shows the specific echographic sign in defining the extent of extracapsular disease with the characteristic image of traction in the rectal wall to the Denonvilliers' fascia; **b** histological image of this specific sonographic sign: marked with black borders is a Gleason 3 + 4 tumor that runs along the midline border of the prostate with established extracapsular extension

Table 1 Clinical characteristics of patients with prostate cancer according to Gleason score

Variable	Gleason score ≤6 (n = 44)	Gleason score ≥7 (n = 24)	P value
Age (years)	63.5 ± 6.69	68.9 ± 7.69	0.001
PSA (ng/ml)	6.5 (2.4–12.7)	8.7 (4.3–22.2)	<0.001
Prostate volume (ml)	49.3 (27–79)	52.1 (26–82)	0.003
Transitional zone volume (ml)	13.2 (9–49)	14.8 (11–63)	0.271
Sonographic signs of extracapsular invasion	41	23	<0.001
Digital rectal examination suspicious	39	21	0.005

basal gland area (51 %), apical carcinoma was detected in 22 % of cases, while mid gland tumours occurred in 26 % of the cases.

There was no difference regarding the side of tumor incidence.

Pathological analysis detected on the prostate's surface, the fusion of DF with PC at the midpoint of the prostatic posterior surface in 64 of the 68 cases (94 %), in 3 cases (4 %) the DF remained at a certain distance from PC in this region and in the remaining case (1 %) lateral pelvic fascia fused with PC and little adipose tissue was present between them ($P < 0.005$).

Discussion

In 1836, the membranous structure between the rectum and the seminal vesicles was named Denonvilliers' fascia after Charles-Pierre Denonvilliers [10]. DF lays at the posterior and lateral angle of the prostate and covers the posterior aspect of the seminal vesicle. DF is composed of

collagenous fibers and occasional muscle fibers were noted in all cases [11].

Lateral insertions of the DF in the dorsal border of the neurovascular bundles were clearly seen and incised from the prostatic base to the apex when performing a NS procedure [12].

Young et al. [13], in a comparative study of histological and ultrasonic appearances of the prostate, suggest that despite the finding of a regular, 'well-defined' ultrasonic capsule, the histological capsule was frequently either absent or correlated very poorly.

Rather, the prostate is surrounded by a fibromuscular band which, although incomplete anteriorly, is an intrinsic part of the gland, and it is adherent to the pelvic connective tissue in regions [8].

Ultrasonography is the most common method used to have a direct visualization of the prostate, primarily because it is essential to imaging-guided prostate biopsies.

Ultrasonography has the advantages of a real-time imaging, portability, handiness use, and low cost. It can visualize the anatomy of the intraprostatic zone, with the peripheral zone showing slightly increased echogenicity compared with the central gland. Prostate carcinoma typically presents as a hypoechoic area within the peripheral zone [14].

Jung et al. [4], in a retrospective and comparative study between T2-weighted magnetic resonance (MR) imaging and TRUS for staging of PCa, showed that B-mode ultrasound demonstrates similar accuracy for depicting locally invasive disease as compared to T2-weighted MR imaging and should be performed more rigorously when evaluating for extracapsular extension.

According to our data, the TRUS allowed a more precise result in terms of tumor extracapsular extension to DF with a detection rate of 95 % in patients with echographic sign of reverb ultrasound at posterior surface of prostate ($P < 0.001$).

Fig. 2 TRUS image in midline transverse plane shows a prostate with (a) and without (b) extracapsular extension of disease

PC is not demonstrable with ultrasound, the glandular margins, however, are constantly defined by the periprostatic adipose tissue, which appears intensely hyperechoic (Fig. 2). Any distortion of this smooth surface induced the suspicion of extracapsular extension of the disease, except at the postero-lateral region of the base, where the neurovascular pedicle approaches the gland, the prostate contour appears hypoechoic and normally not defined.

In RP, dissection of the posterior surface of the prostate is performed at the layer between the rectum and DF, and the prostate is removed with DF [15]. In our study at the midpoint of the prostate posterior, the DF fused with the PC in 94 % of the case.

DF forms an important barrier to the spread of prostate and rectal malignancy. It is generally more adherent to the prostate, except in disease states [16, 17].

Finally, the limitation of our study is that it was conducted in a single institution, a highly specialized tertiary care center, and the results may not be generalizable to community practices, especially those with less experienced ultrasound interpreters.

Conclusion

In our opinion, it is very important to recognize preoperatively the possibility of extracapsular extension cancer to the DF and the wall of the rectum, through an examination of simple and low cost as TRUS.

The RP (open surgery, laparoscopy or robotic-assisted procedures) allows the dissection and identification of the different fasciae surrounding the prostate and the preservation of the neurovascular bundles [15]. However, fascial dissection remains conditioned by oncologic radicality, tumor location, size and Gleason score. It has a dramatic impact on quality of life due to impotence and the increasing risk of iatrogenic surgical margins.

Therefore, the preoperative demonstration of extracapsular disease in PCa has become essential in our clinical practice for choosing therapeutic treatment and compilation of informed consent in surgery.

Conflict of interest Lucio Dell'Atti declares that he has no conflict of interest.

Informed consent All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). All patients provided written informed consent to enrolment in the study and to the inclusion in this article of information that could potentially lead to their identification.

Human and animal studies The study was conducted in accordance with all institutional and national guidelines for the care and use of laboratory animals.

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