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Original Research

Fusion prostate biopsy: tips and tricks to improve rigid registration

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Abstract

Background: We introduced tips and tricks to improve the rate of correct rigid registration during fusion prostate biopsy: (1) creation of similar anatomical condition during multiparametric magnetic resonance of the prostate (mpMRI) and trans rectal ultrasound (TRUS) (bladder and rectum should be empty and the use of MRI trans rectal probe avoided), (2) revision of mpMRI performed outside our institution by our radiologist, (3) the use of the boundary between transitional/central and peripheral zone of the prostate as the main anatomical landmark (less prone than the peripheral shape to deformation) at the level of the target, (4) repeating the registration at the level of every target or after unintended movement of the patients. **Methods**: We reviewed our internal database to assess the impact of our tips and tricks. Patients submitted to radical prostatectomy after fusion biopsy in our centre over the last two years were selected. Biopsy positivity in a sextant with cancer at the radical prostatectomy and a suspected mpMRI (3–5) was computed as a correct registration, the positivity of a biopsy in an adjacent sextant as a quasi-correct registration. **Results**: 49 out of 59 and 5 out 59 correct and quasi-correct registrations were finally computed. Assuming acceptable 90% of correct and 95% of quasi-correct rate, the expected figures are respectively 53 and 3. The chi-square goodness of fit test show a X square value of 2.97 and a *p*-value of 0.23. Therefore, the null hypothesis that the two distributions are homogeneous cannot be rejected. **Conclusions**: The introduction of some tips and trick in the daily clinical practice contributed to some extent to a satisfactory rate of correct rigid registration in our series of fusion prostate biopsies.

Keywords: prostatic neoplasms; multiparametric magnetic resonance imaging; needle biopsy

1. Introduction

Prostate biopsy is the leading tool for the diagnosis of prostate cancer. Since the inception of standardization of the prostate imaging reporting and data system (PI-RADS) score, mpMRI has fast gained attention and it has become a guideline. The fusion of mpMRI T2 sequences in real-time combined with the ultrasound scan during the biopsy (the so-called "fusion biopsy") is a technological improvement that has fast spread among the urological community [1]. The main issue of the fusion biopsy is to obtain a reliable overlap of TRUS and mpMRI iamges. Techically, the image registration may be elastic or rigid. Up to date, no significant differences have been reported between the two modalities [2–4]. Registration is based on the identification of anatomical landmarks usually the largest diameter and the peripheral shape of the gland. However, even after a correct identification, the shape of the prostate at TRUS may not perfectly overlap, leading to an eventual targeting error. Since 2016 we have been applying fusion biopsy in our centre with a rigid registration system, the Esaote Virtual Navigator@. During practice, we refined the registration process with the introduction in the clinical practice of some tips and tricks to improve rigid registration. These tips and tricks are (1) creation of the same anatomical shape of bladder and rectum during mpMRI and TRUS biopsy (bladder and rectum should be empty and the use of MRI trans-rectal probe avoided); (2) revision of mpMRI performed outside our institution by our radiologist; (3) using the boundary between peripheral and central/transitional zone of the prostate (which is less prone to deformation respect to the periphery of the gland [5]) at the level of each target as a main anatomical landmark, and (4) repeating the registration at the level of every target or after unintended movement of the patients.

To assess the impact of our technical modification on the registration process, we reviewed our institutional database of fusion prostate biopsies.

2. Materials and methods

2.1 Preparation to biopsy

Before performing mpMRI and fusion biopsy, the patient is invited to urinate and perform a cleansing enema to have similar anatomical conditions. MpMRI performed with a trans rectal probe were excluded because of the severe deformation of the prostate. Every mpMRI not performed in our centre was reviewed to reassess PI-RADS score by the radiologist specialized in mpMRI in our centre (RT, EU).

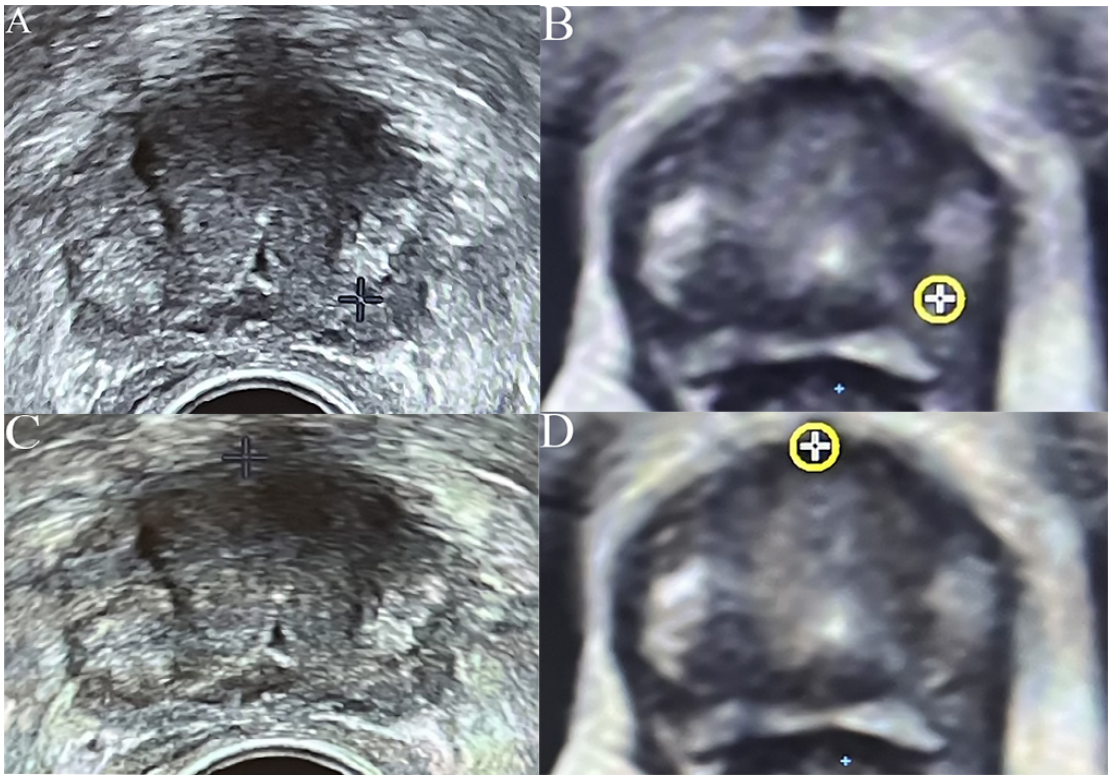

Fig. 1. On the left TRUS (A,C) and on the right mpMRI (B,D). The cross in the pictures shows the boundary among central/transition and peripheral zone and the boundary of the anterior zone of the prostate. Urethra, and rectal wall may be seen in both modalities further confirming the correct overlap of the images.

2.2 Biopsy technique

We perform a transrectal biopsy with an Esaote MyLab system@ (Esaote, Genova, Italy). An oral cephalosporin is recommended starting from the day before the procedure. Rectal swabs and urine culture are not routinely prescribed. The administration of low-dose aspirin is not interrupted even other antiplatelet or anticoagulant therapies must be suspended. Bridging therapy is not routinely necessary if there is no bleeding after the procedure. The first step is to identify the mpMRI suspected areas and mark them. The second step is the local anaesthetic ultrasound-guided injection along with the neurovascular bundles from the base to the apex of the gland. We perform it before the registration; thus, we may account for the eventual deformation of the gland profile. The third step is registration. We fix the mpMRI on the suspected area and then look at TRUS to find the exact overlapping scan. The main landmarks are (1) rectal wall, (2) boundary among transitional/central and peripheral zone of the gland, (3) profile of the periphery of the gland (Fig. 1). The registration usually takes a minute or less, and it is repeated at every target during the biopsy. The gland is subdivided into sextants (right/left apex, middle lobe, or prostate base). Two or three cores are taken for each target. Finally, random sampling is performed. We do not re-biopsy a sextant containing a target to minimize the total number of cores taken.

2.3 Objective

To assess the rate of successful registration, we retrospectively reviewed our internal database of fusion prostate biopsies. We selected patients who performed fusion prostate biopsy and were eventually submitted to radical prostatectomy in our centre during 2020 and 2021. Concordance between mpMRI and radical prostatectomy findings was considered a true positive finding of mpMRI in a specific sextant. Biopsy positivity (at least one core) in the same sextant was considered a correct registration as we never take random biopsies in a sextant with a target. Biopsy positivity in a sextant adjacent to the target was considered a quasi-correct registration.

2.4 Statistical analysis

We fixed at 90% and 5% a satisfactory rate of correct and quasi correct registration. To find out if our findings comply with those expected rate, we chose the chi-square goodness of fit test that is able to assess whether or not a categorical variable follows a hypothesized distribution (StataCorp 2011. Stata Statistical Software: Release 12. TX: StataCorp LP, College Station, TX, USA).

3. Results

In our centre, during 2020 and 2021, 356 prostate biopsies were performed, 144 with the fusion technique. 94 out of 144 patients were found with prostate cancer, 37 of them underwent radical prostatectomy in our centre. Patients' characteristics are reported in Table 1.

Table 1. Patients' characteristics.

	Number of patients, (%)	Median (ng/mL), IQ range (ng/mL)
T2	24 (65%)	
T3	13 (35%)	
Gleason score sum 3+3	5 (13.5%)	
Gleason score sum 3+4	20 (54%)	
Gleason score sum 4+3	7 (19%)	
Gleason score sum $\geq$8	5 (13.5%)	
PSA		7.2, 4.8

Overall, 61 out 222 sextants (corresponding to 37 patients) had a PI-RADS 3–5 area, which was sistematically submitted to a targeted biopsy following the registration process. 59 out of those 61 sextants were found with cancer after examination of the radical prostatectomy specimen. The biopsy was positive in 49 out of those 59 sextants Regarding the remaining 10 sextants, 5 had an adjacent sextant with cancer. Therefore the registration process was considered correct 49 times, quasi-correct 5 times, and wrong 5 times.

We assumed as acceptable the 90% of correct findings and the 5% of quasi-correct; thus, the expected figures are, respectively, 53, 3, and 3. The chi-square goodness of fit test shows an X square value of 2.97 and a *p*-value of 0.23. In other terms, the null hypothesis that the two distributions are homogeneous cannot be rejected.

4. Discussion

Thanks to technological improvement, mpMRI certainly was a major outbreak in the management of prostate cancer. Its use before a first negative biopsy or even before the first biopsy is recommended by EAU guidelines, notwithstanding its recent introduction in clinical practice [6]. Comparatively, robotic radical prostatectomy is not yet guidelines even if the technology has been introduced many years before [6]. Fusion biopsy has gained rapid consensus among the urological community. It has a relevant advantage over real-time in-bore MRI-guided biopsy because it remains an office and far less expensive procedure and over cognitive fusion, which can be equivalent only in the hand of experienced operators [1]. The main issue of the fusion technique is to achieve an image overlap as reliable as possible. Image registration may be elastic or rigid whether a software adjustment accounting for prostate deformation is provided or not. Up to date, no significant difference in terms of cancer detection rate has been found in a systematic review [2]. Overall, there is a consensus that rigid registration may be obtained faster and easier while achieving the same accuracy [3,4]; this may be more accurate in the peripherical zone of the prostate [4], where most of the cancers develop. However, it has also some limitations [4]. Elastic fusion is based on an algorithm that considers the deformation of the prostate shape caused by the pression of the probe, rectal, and bladder filling volume. Even if it may appear palatable at first glance, it has some remarkable pitfalls. The process of registration involves the whole gland. Paradoxically, once performed, it refers to a static model registered in the computer (the so-called contouring), so that, even a slight variation of the pressure exerted on the probe and transmitted to the gland or involuntary movements of the patient during the procedure, may require to repeat it. Moreover, the registration algorithm adjusts mpMRI images to an ultrasound scan. It may result in a hampered accuracy of mpMRI at the periphery of the gland. Overall, the risk is to sample outside target, especially in the anterior peripheral part of the gland, precisely, where most of the tumours were not detected before the advent of mpMRI. The rigid registration process is much less complicated to carry out. It is completed when a real-time overlapping of mpMRI and TRUS is achieved. To perform the registration largest diameter or specific anatomical landmarks are usually identified. However, also rigid registration has some flaws. The scanning angle of ultrasound may vary concerning the cross-sectional imaging of mpMRI. Moreover, there is no compensation for prostate shape deformation; therefore, performing the correct overlapping process may be challenging. Hence, it may be arduous to find a unique registration satisfactory for the whole gland volume at the same time. On the other hand, the registration may be repeated several times during the procedure, adjusting for every target area of the prostate or compensating for the unintentional movements of the patient. We have been performing fusion biopsies with a rigid registration system since 2016 (Esaote Virtual Navigator@, Esaote, Genova, Italy). Over the years, we introduced some tips and tricks to overcome the flaws. First, we recommend performing mpMRI without the aid of an MRI rectal probe that may lead to significant deformation of the prostate shape during the images acquisition. Second, we suggest performing MRI and biopsy with an empty bladder and rectum to have similar anatomical conditions. Third, we execute the registration at the level of the target. To this purpose, the leading anatomical landmark of our registration technique is the boundary between the periphery and transitional/central zone of the gland, which is much less prone to deformation concerning the peripheral contour of the gland [5]. Finally, we repeat the registration for every target at the level of each target within the gland. Since 2016, we have been updating an internal database of fusion prostate biopsies. We registered the presence of sus-

pected area at MRI, results of the biopsy, and pathological findings of radical prostatectomy specimens, dividing the prostate in sextants. Since the last update of the PIRADS score of 2019 [7], we have been evaluating the procedures of the recent two years. Our objective was to assess the rate of successful registration. We selected sextants from the database where both the mpMRI and the specimen were positive. The presence of cancer was definitive proof of true positive mpMRI. Then, we assessed if the biopsy in the sextant, the target biopsy (we always avoid random sampling in a sextant with a target), also identified cancer. The rate was 49/59; this implies an efficient registration process in a real-life clinical scenario. Indeed, the success rate is not 100%, and therefore random sampling remains crucial to detect prostate cancer. We are aware of the retrospective nature of the study. Another bias is the impossibility of assessing the reliability of the patients not submitted to radical prostatectomy. Moreover, sextant division of the gland may be an excessive approximation. Finally, a prospective study that compares data before and after introducing our rules would have been more informative about their impact on the registration process. Nevertheless, as PI-RADS score attribution changed significantly before and after 2019 [7] and the introduction of tips and tricks progressed from 2016 to 2018, we cannot perform a compartive study. However, to what extent tips and tricks impact the rate of a correct registration remains uncertain.

5. Conclusions

The introduction of some tips and trick in the daily clinical practice contributed to a satisfactory rate of correct rigid registration in our series of fusion prostate biopsies.

Abbreviations

mpMRI, multiparametric magnetic resonance of the prostate; TRUS, trans rectal ultrasound; PSA, prostate-specific antigen; PI-RADS, prostate imaging reporting and data system; EUA, European Association of Urology.

Author contributions

AN and IO performed the biopsies, introduced the tips and tricks and analysed data; NP performed all the pathological examinations and maintain the database; EU and RT performed or reviewed all mpMRI and maintain the database; AG supervised the paper drafting. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate

Approval from the Ethical Committee of our institution was not asked since it is a retrospective analysis of a standard procedure.

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Conflict of interest

The authors declare no conflict of interest. AN is serving as one of the Editorial Board members and Guest editors of this journal. We declare that AN had no involvement in the peer review of this article and has no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to CHCK and AT.

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