GEORGIAN MEDICAL NEWS

ISSN 1512-0112

NO 6 (339) Июнь 2023

ТБИЛИСИ - NEW YORK

ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

Monthly Georgia-US joint scientific journal published both in electronic and paper formats of the Agency of Medical Information of the Georgian Association of Business Press. Published since 1994. Distributed in NIS, EU and USA.

GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

GEORGIAN MEDICAL NEWS
No 6 (339) 2023

Содержание:

GEORGIAN MEDICAL NEWS
No 6 (339) 2023

BRIDGING GAP BETWEEN PRE AND POSTOPERATIVE PROSTATE BIOPSIES: PI RADS CORRELATION WITH FINAL HISTOPATHOLOGICAL DATA

Tsitsino Abakelia[1]*, Ketevan Lashkhi[2], Sophio Kakhadze[1,2].

[1]*Iv. Javakhishvili Tbilisi State University, Faculty of Medicine, 78 Beliashvili st., 0159, Georgia, Tbilisi.*

[2]*Acad. F. Todua Medical Center, Magnetic Resonance Imaging Department, 13 Tevdore mghvdeli st., 0112, Georgia, Tbilisi.*

Abstract.

Objectives: We aim to define strength of correlation between Prostate Imaging Reporting and Data System (PI RADS) scores of prostate cancer and final histopathological data-postoperative Gleason scores (Gs); apparent diffusion coefficient (ADC) and Gs; to define mean ADC values for each Gleason grade as well. To determine compliance of MRI data in preoperative prostate cancer grading with gold standard-morphological data. **Methods:** 203 consecutive patients suspected for prostate cancer (Pc) on multiparametric MRI, who underwent subsequent preoperative TRUS or MRI/Ultrasound fusion guided biopsies were included to this study prospectively. 50 patients were excluded due to preoperative negative prostate biopsies, leaving 153 treatment-naïve patients, with positive preoperative biopsies. Multiparametric MRI (mpMRI)s were interpreted utilizing PI RADS V.2.1; this data was correlated with histopathological findings. Concordance of preoperative and postoperative Gleason scores was evaluated as well. **Results:** Relationship of PI RADS and Gleason scores was defined by Pearson's correlation. It revealed a highly positive correlation of PI RADS sum scores and Gleason scores (r=0.646 and p=0.000.) A high negative correlation was seen between apparent diffusion coefficient (ADC) and Gleason scores (r=-0.849 and p=0.000). Mean ADC values were calculated for each Gleason group. 18 patients out of 153 showed Gs upgrade from TRUS biopsies to prostatectomy specimens. **Conclusion:** PI RADS sum scores and Gleason grades demonstrated significantly high correlation for our patients. With apparent diffusion coefficient calculation PI RADS preoperatively can predict Gs noninvasively and this makes mpMRI valuable tool in preoperative prostate cancer grading, as it gives reliable data among pre and postoperative pathological reports providing an optimal treatment strategy.

Key words. Prostate cancer, multiparametric-MRI, PI RADS, gleason score, correlation.

Introduction.

Prostate cancer(Pc) is the second most commonly diagnosed cancer in men population. According to the global cancer observatory (GCO) , there were over 1 414 259 new cases of Pc and 375 304 men have died of prostate cancer in 2020 [1]. In clinical practice treatment strategy and therefore survival outcomes of Pc depend on histopathological grade of the tumor evaluated by Gleason scoring system; it involves five histological growth patterns defining tumor grade [2]. In the recent past transrectal ultrasound (TRUS) guided biopsy was the most popular tool to derive Gleason score (Gs). However, TRUS biopsy showed differences in Gs with prostatectomy specimens; moreover, sextant biopsies under sample most prostates and may miss small index lesion, leading to the false negative results, which causes to late cancer detection and overly intensive treatment (in up to 40%) [3-6]. Multiparametric magnetic resonance imaging(mpMRI) and MRI-targeted biopsy demonstrated potential to solve this problem, with high accuracy in prostate cancer diagnosis [7].

In this paper the matter for consideration is mpMRI in Pc diagnosis with risk stratification system-Prostate Imaging Reporting and Data System (PI RADS). This system was established by European society of urogenital radiology (ESUR) as scoring system with strict criterions for categorization of suspected lesions in prostate gland, whereby a score level 1 to 5 corresponds to the like hood of clinically significant cancer. With this system mpMRI noninvasively predicts tumor grade [8]. Score level 1 to 5 are applied to lesion for each single mpMRI sequences considering zonal location of suspected lesion. PI RADS involves several mpMRI sequences: T2 weighted imaging(T2W)-for structural representation of lesion; Diffusion weighted imaging(DWI) with apparent diffusion coefficient(ADC) - correspond with micro-architecture of tissue and dynamic contrast enhanced imaging(DCE)-to assess tumor vascularity [9]. At the time of primary diagnosis high diagnostic accuracy is crucial for an optimal Pc management. Preoperative prediction of Pc grade with high accuracy and evaluation of tumor extension at the time of diagnosis may modulate treatment strategy and therefore impact on cancer prognosis: survival rate, quality of life-especially in patients with indolent tumor, for whom potential risks of surgery outweights the survival benefit. We hypothesize that pre-biopsy mpMRI with PI RADS as valuable tool among pre and postoperative Pc grading can show high reliability in preoperative Pc grading, thus modulating Pc management. Existing literature regarding discrepancy between the pre- and post-operative pathological Gleason scores strengthens this hypothesis [10]. There are limited number of published studies in total evaluating possibilities of mpMRI in preoperative Pc grading, defining strength of PI RADS correlation with Gs, finding compliance of Pc grades generated from PI RADS and Gleason scoring system. Existing literature revealed PI RADS as strong predictor for significant Pc detection, however with different results and conclusions[11-15]. Studies investigating reliability of mpMRI in Pc preoperative grading, by evaluating the correlation of PI RADS with Gs are needed. The purpose of this study was to find the strength of correlation between mpMRI and histopathological data in prostate cancer diagnosis. Our approach allowed us to directly compare MRI features of Pc to histological features and provide a model to reconcile our findings and those of others.

Materials and methods.

Study population: In Acad. F. Todua Medical Centre from June 2020 to September 2022 203 consecutive patients suspected of Pc who underwent preoperative mpMRI were included in this study prospectively. Inclusion criteria were

patients suspicious for Pc (on ultrasound sonography, on digital rectal examination, or with elevated blood PSA levels) and consecutive positive biopsy with Gleason scoring. Exclusion criterions: prostate cancer positive patients who underwent any type of Pc treatment: radical prostatectomy, Trans-urethral resection of the prostate (TURP), radiotherapy, hormone therapy or chemotherapy. Among the patients enrolled in this study(n=203) who underwent histopathological examination with Gleason scoring 50 patients were excluded due to the negative biopsies for Pc on follow up. In total 153 patients were included in the final analysis (Figure 1).

Radiological technique: mpMRI was performed on a 3T scanner-Magnetom Skyra, Siemens AG, Erlangen, German ; using 18-channel phased array body coil. mpMRI examination included:T2W;DWI;ADC and DCE-MRI sequences covering the entire pelvic region. DWI sequences were taken in transverse plane with three values (50;400;1000 s/mm2); restricted diffusion was measured by the ADC map [16]. DCE images were obtained using fast T1 weighted imaging (gradient echo sequence) in transverse plane. Contrast medium-Gadovist was used with a dose of 0,1mL/kg body weight [17].

Image interpretation: mpMRIs were interpreted by board-certified two experienced radiologists independently. Firstly, the three single scores from 1 to 5 were defined for T2W,DWI,ADC and DCE sequences according to the ESUR guidelines PIRADS v2.1 and then overall PI RADS scores were calculated [9,18]. In order to limit biased image interpretation, performing mpMRI reports and PI RADS scoring were done before biopsy or surgery, so radiologists were blinded to the morphological outcomes.

Biopsies were derived by TRUS guided biopsy (137 patients) and MRI/Ultrasound fusion guided biopsy in 16 patients. Biopsy samples were examined and analyzed by experienced pathologists who were blinded to MRI findings. During a follow up Gleason score of TRUS and MRI/Ultrasound fusion guided biopsies were compared with prostatectomy specimens. Discrepancy of histopathological grades between biopsies and radical prostatectomy was found in 18 patients. Upgraded Gleason scores of prostatectomy specimens were considered for the final data analysis.

Statistical analysis: SPSS, version 27.0 was used for all statistical analysis. Baseline characteristics of patients with pathological outcomes were compared using a chi-square test for categorical data (PIRADS score) and a Student t-test or ANOVA for continuous data. Linear regression analysis was performed to analyze the correlation between the rising PI RADS scores and prognostic factors. Pearson's correlation coefficient was calculated for PI RADS and Gs, ADC and Gs. P values less than 0.05 were considered statistically significant. A receiver operating characteristic (ROC) analysis was used to evaluate sensitivity and specificity of the scoring system with regard to tumor incidence. Linear regression analysis was used to predict Gleason grades with regards to different ADC values. Concordance of pre and postoperative Gleason scores was verified by Bland-Altman plot.

Results.

patients age ranged from 54 to 89 (mean age 69 SD 7,0); the preoperative mean total PSA value was 76.0899ng/ml. (range:4.30-1134.00ng/ml. SD 156.33) When mpMRI data was analyzed mean tumor volume was defined as 6.5cm^3; Tumor sizes showed low positive correlation with Gs (r=0.210 p=0.009) and PI RADS sum scores (r=0.215 p=0.008); low negative correlation with ADC (R=-195 P=0.16);

Most frequent location of tumor was detected in right peripheral zone (47.1% n=72). mpMRI evaluated spread of each lesion: 54.9% n=84 was defined with extracapsular extension. Mean PI

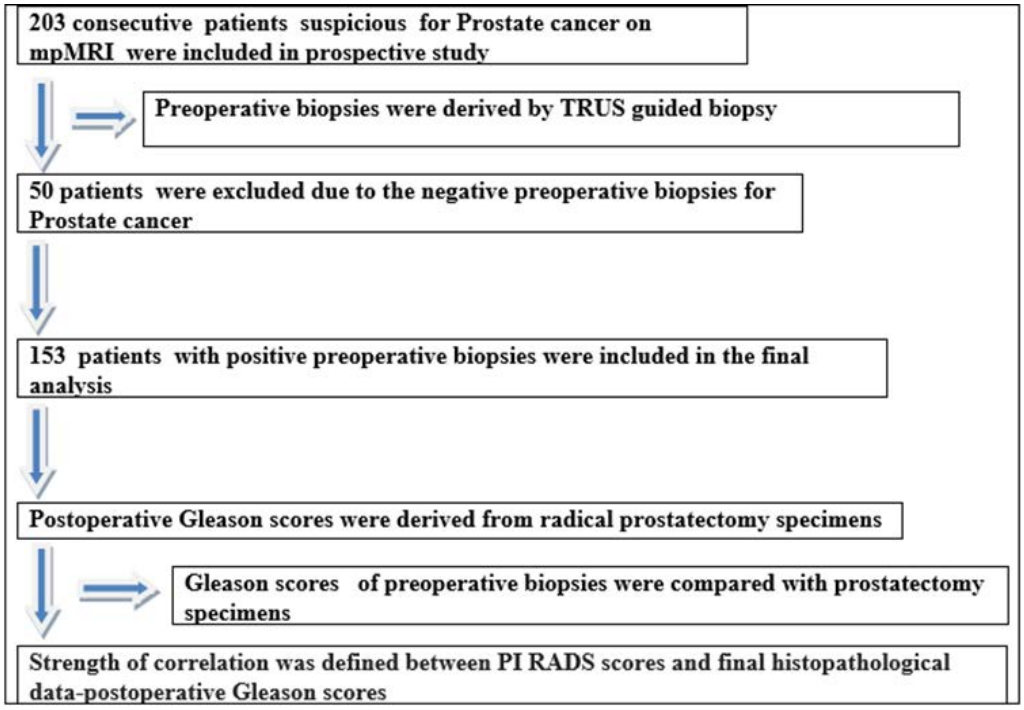

Figure 1. *Flow chart of materials and methods.*

RADS sum score for tumors with extracapsular extension was defined as 14 ; Mean sum score for tumors with no extracapsular extension was 12. Conducted T test showed statistically reliable differences between them: t=6,40 and p=0.000.

Overall, PI RADS score distribution was as follows: in total PI RADS 3 was given to 54 patients (47 with negative biopsies and the rest of 7 patients with positive biopsies (4,6% out of 153), PI RADS 4 to 35.9% and PI RADS 5 to 59.5%. Low grade tumors (Gs 6) were found in cutoff between PI RADS sum score 8-13; intermediate grade tumors (Gs 7) in cutoff between 10-14; Gs 8 in cutoff 8-15 and very high-grade tumors (Gs9-10) in cutoff of 12-15. All PI RADS 3 lesions were associated with different grades (PI RADS sum score range from 8 to 13). Grade group 5(Gs9 and Gs10) were linked to overall PI RADS 5 (sum score range:12-15). The relationship of Gleason grades and PI RADS sum scores is demonstrated in cross-tabulation analysis (Chi-Square is 147,9 P=.000) (Table 1).

Regarding tumor malignancy: 9.8% were cancers with Gs 6(3+3); 16.3% with Gs 7(3+4); 14.4% with Gs 7(4+3); 17% with Gs 8(4+4); 18.3% with Gs8(3+5); 3.3% with Gs8(5+3); 12.4% with Gs9(4+5); 5.2% with Gs9(5+4); 3.3% with Gs10(5+5) (Table 2).

Mean ADC values were calculated for each Gleason grade and illustrated by box plot analysis (Figure 2). Grade 1 with mean ADC 0.88 and grade 5 with mean ADC 0.67. ADC values decreased relative to Gleason score upgrade. 50 patients with negative biopsies received mean ADC value 1.34. Fisher's test determined statistically reliable difference between Gleason groups (F=89.85 and P=0.000). In accordance to linear regression analysis (R Square=0,74), with Gleason upgrade by one group- ADC decreases by 0,046 unit (B=-27.3 da p=0.000).

Dynamic Contrast-Enhanced MRI was assessed by observation on enhancement curves for each patient, deriving single scores from algorithm-based approach. In summary 19 patients (12.4%) received type 1 enhancement curve; 56 patients(36.6%) with type 2 enhancement curve and 78 patients (51%) with type 3 curve. DCE curves Correlation with Gs was as follows: high positive correlation with Gleason scores (r=0.689 p=0.000); intermediate positive correlation with PI RADS sum scores: r=0.435 p= 0.000; high negative correlation with ADC values: r=-0.592 p=0.000. Type 1 enhancement curve was associated with Gleason grade group 1,2 and 3; while Type 3 enhancement curve was associated with Gleason grade group 2,3 ,4 and 5 (Table 3).

Table 1. *Cross-tabulation analysis demonstrates the relationship of Gleason grades and PI RADS sum scores.*

Pi rads sum score	**Gleason score**				
	Grade 1	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
8	50.0%			50.0%	
9	66.7%			33.3%	
10	33.3%	16.7%	33.3%	16.7%	
11	33.3%	42.9%	14.3%	9.5%	
12		28.6%	35.7%	25.0%	10.7%
13	13.3%	13.3%	33.3%	40.0%	
14		11.4%	4.5%	68.2%	15.9%
15				31.3%	68.8%

Table 2. *Cross-tabulation analysis shows the relationship of Gleason scores and PI RADS sum scores.*

Pi rads sum score	**Gleason score**								
	6(3+3)	**7(3+4)**	**7(4+3)**	**8(4+4)**	**8(3+5)**	**8(5+3)**	**9(4+5)**	**9(5+4)**	**10(5+5)**
8	50.0%			25.0%		25.0%			
9	66.7%			33.3%					
10	33.3%	16.7%	33.3%	16.7%					
11	33.3%	42.9%	14.3%	4.8%	4.8%				
12		28.6%	35.7%	14.3%	7.1%	3.6%	10.7%		
13	13.3%	13.3%	33.3%	26.7%	6.7%	6.7%			
14		11.4%	4.5%	25.0%	38.6%	4.5%	11.4%	4.5%	
15				9.4%	21.9%		34.4%	18.8%	15.6%

Table 3. *Dynamic contrast-enhanced MRI (DCE) curve distribution with regard to histopathological outcome.*

Dynamic contrast-enhanced MRI	**Gleason score**									**Total**
	6(3+3)	**7(3+4)**	**7(4+3)**	**8(4+4)**	**8(3+5)**	**8(5+3)**	**9(4+5)**	**9(5+4)**	**10(5+5)**	
Type 1 enhancement curve	31.6%	47.4%	21.1%							100.0%
Type 2 enhancement curve	16.1%	26.8%	28.6%	10.7%	12.5%	1.8%	3.6%			100.0%
Type 3 enhancement curve		1.3%	2.6%	25.6%	26.9%	5.1%	21.8%	10.3%	6.4%	100.0%
Total	9.8%	16.3%	14.4%	17.0%	18.3%	3.3%	12.4%	5.2%	3.3%	100.0%

Strength of correlation between PI RADS, Gleason and ADC values were determined by Pearson's correlation. According to this analysis: there is strong positive correlation between PI RADS sum scores and Gleason scores (r=0.646 and p=0.000.) which means that higher PI RADS sum scores are associated with higher Gleason scores. In summary each of the single scores showed a tendency to higher tumor incidence (Figure 3). ADC correlates with Gleason score with high negative correlation (r=-0.604 and p=0.000)- lower ADC value is associated with higher Gs.

Receiver operation characteristic (ROC) analysis revealed large area under the curve of 0.80 (95% CI 0.74 to 0.87) regarding tumor incidence (p=0.000); when analyzing the balance between sensitivity and specificity to calculate reliable threshold for prostate cancer incidence for the PI RADS sum-score, the score level of ≥ 9 was the highest possible threshold with more sensitivity than specificity(94%/67%) for the predictions of cancers with Gleason score ≥3+4. (Figure 4).

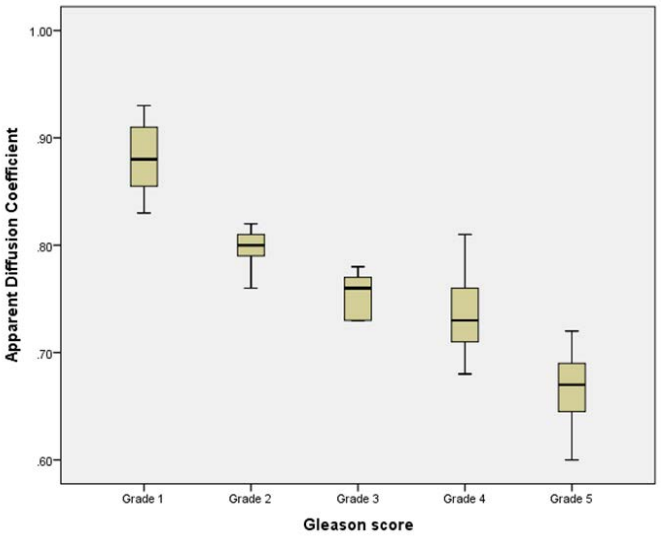

Figure 2. *Box plot analysis of mean ADC values with regard to Gleason scores.*

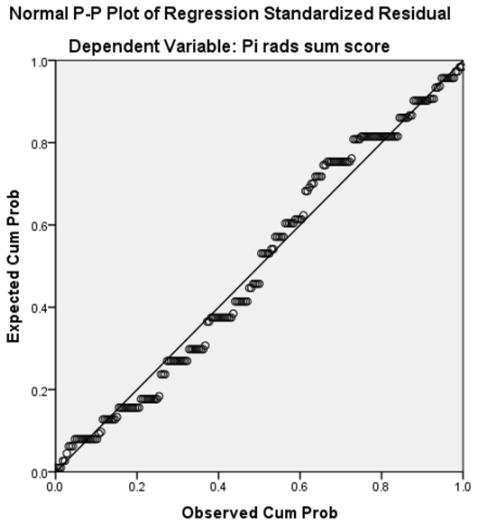

Figure 3. *Scatter plot demonstrates strength of correlation between PI RADS sum scores and final diagnose-postoperative Gleason scores.*

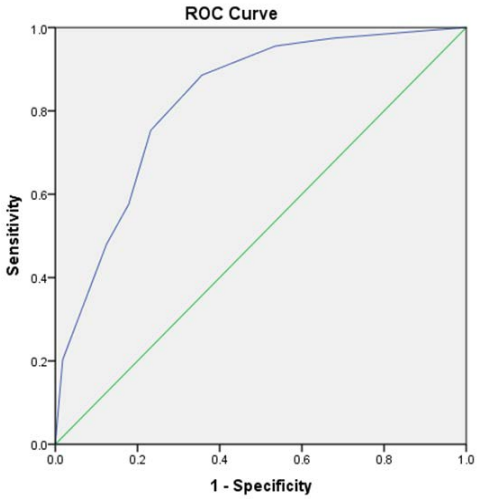

Figure 4. *Receiver operation characteristic (ROC) curve for the PI RADS sum-score, regarding threshold for tumor incidence.*

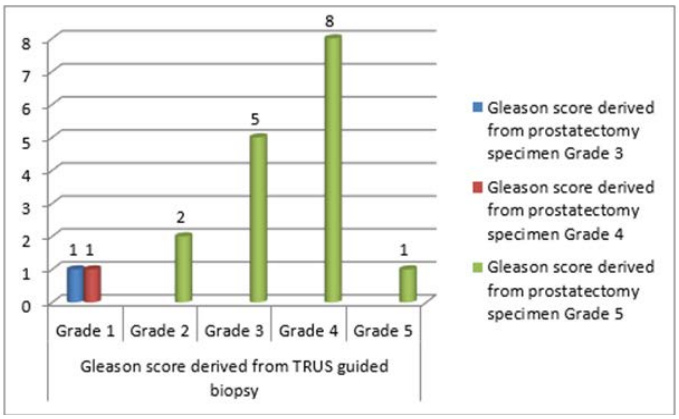

Figure 5. *Gleason score upgrade from TRUS biopsy to radical prostatectomy.*

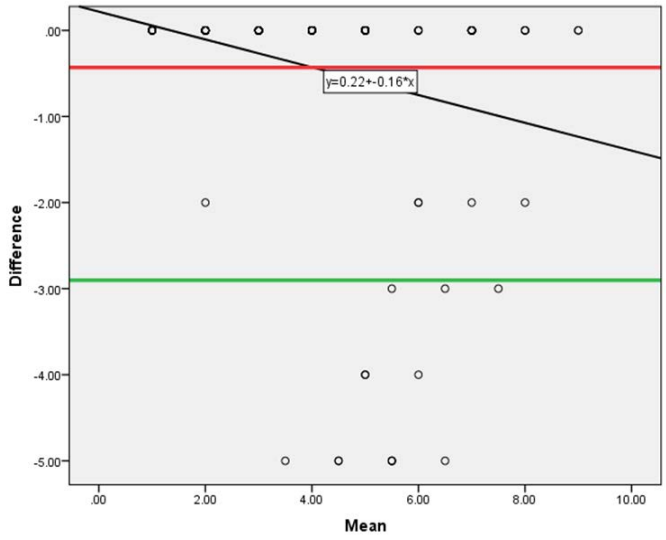

Figure 6. *Bland-Altman plot shows limitation of agreement between TRUS biopsy and prostatectomy specimen.*

With regards to Gleason score upgrade from biopsy to radical prostatectomy: In presented study we evaluate agreement between preoperative and prostatectomy final Gleason

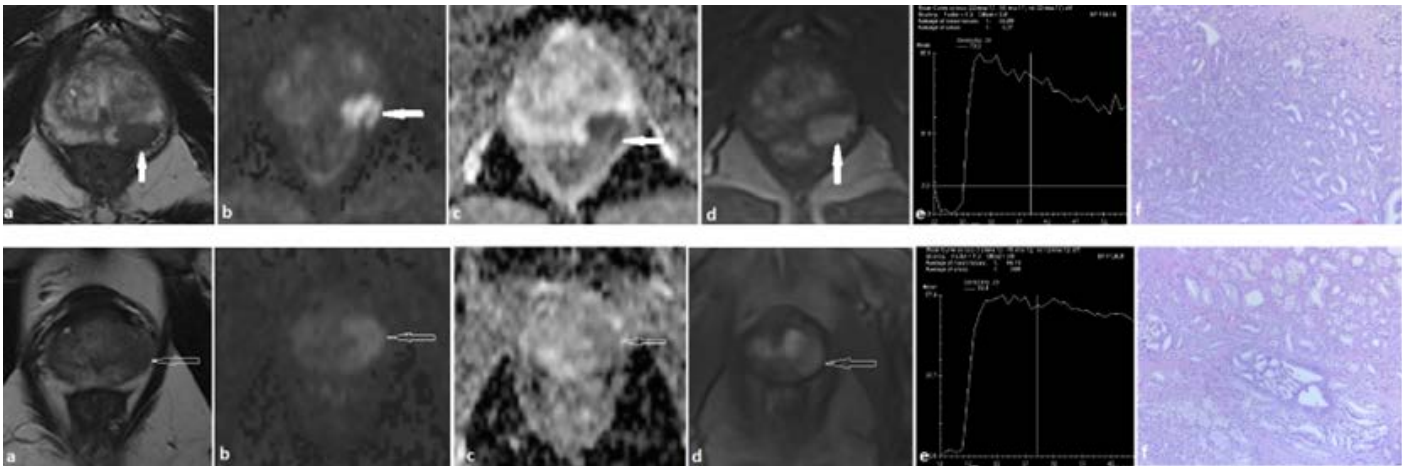

Figure 7. *Suspicious lesions (arrows) on mpMRI with different PI-RADS sum-scores and Gleason scores.*
First row: 4 points on T2W for homogeneous hypointensity (a); 5 points on DWI for focal very low ADC (b,c); and 5 points on DCE-MRI for washout curve in a focal lesion (d); type 3 enhancement curve (e); sum-score of 14 points. Microgram-Gleason score 8(3+5) carcinoma (f). Second row: 2 points on T2W for not well demarcated linear area of hypointensity (a); 4 points on DWI for focal area of reduced ADC but isointense signal intensity on high-b-value images(b,c); 4 points on DCE-MRI for progressive signal intensity stabilization followed by a slight and late decrease in signal intensity without focal lesion (d); type 2 enhancement curve (e); = sum-score of 10 points. Microgram-Gleason score 7(3+4) carcinoma (f).

groups. 153 patients with positive biopsies underwent radical prostatectomy. 18 cases out of 153 (11.7%) (7 patients with PI RADS 3 and 9 patients with PI RADS 4) showed discrepancies with Gleason score upgrade (Figure 5).

Bland-Altman plot shows limitation of agreement between biopsy and prostatectomy specimen. All values along the zero are cases with the same Gleason groups at pre and postoperative histology. Red line represents mean difference of pre and postoperative Gleason scores (p=0.000 t=4,233); green line represents lower edge of both Gleason scores. Below green line are distributed findings with significantly big differences (Figure 6).

Discussion.

With this study we could demonstrate good reliability of the PI RADS risk stratification system with regards to tumor malignancy: all single scores, sum scores of 3-15 points and overall PI RADS scores showed clear association with tumor malignancy and incidence. Our research suggests growing potential of mpMRI in pretreatment stage of prostate cancer management avoiding unnecessary interventions, reducing side effects, providing determination of precise treatment approach; all of these shall improve quality of life in patients with prostate cancer. PI RADS component: DWI coupled with ADC; dynamic enhancement curves are making it easier to predict tumor aggressiveness. These features have the potential to uncover tumor patterns and characteristics that fail to be appreciated by the naked eye. PI RADS as a risk stratification system could provide valuable information for stakeholders regarding grade of tumor, extension and staging. It should be used as the clinical selection criterion for active surveillance. PI RADS sum score calculation by summing up each single score derived from mpMRI sequences should be mandatory for each clinical report of individual patients suspicious for Pc; it could provide recommendations for further management. In clinical routine PI RADS assessment based on overall PI RADS derived from subjective impression of radiologists seems to be less reliable than separate classification of sum scores based on algorithm strict criterions [8]. Accordingly, PI RADS sum score calculation preferably should be in line with MRI report (Figure 7).

Some studies regarding radiological and morphological correlation of Pc in concordance with our findings showed an important correlation of PI RADS with histopathology. Unlike to us authors of multicenter study conducted in Turkey placed emphasis on radical prostatectomy features-histopathological factors in prostatectomy specimen and did correlate postoperative extracapsular extension, lymphovascular invasion and seminal vesicle involvement with PI RADS scores. All of these prognostic factors showed significant correlation with PI RADS score [12]. Similar to our study authors concluded that PI RADS high scores were associated with adverse histological features [19]. Other study in retrospective analysis results showed that PI RADS correlates with Pc defined as Gs >3+4 [14]; In a prospective analysis of Pc prediction from biopsy to radical prostatectomy, authors concluded that PI RADS V2.0 score was an independent predictor of postoperative Gs upgrading [5]. Hectors et al. published data with slightly different approach in comparison with our study with following conclusion: machine learning prediction models showed fair performance to predict a Gleason score of 8 or greater (AUC 0.72) [20]. Similar to our study is Rayn et al.'s publication with larger sample size comparing mpMRI features and preoperative biopsies to prostatectomy specimen. Conclusion was as follows: mpMRI alone or in addition to existing validated risk stratification tools, provides significant additional predictive ability for adverse pathological features at the time of radical prostatectomy [21]. Important multicenter study was performed in 2019, in aim to assess the accuracy of mpMRI for the detection of prostate cancer in men undergoing radical prostatectomy. Similar to our study MRI data was compared to final histopathology; however, with slightly different approach: mpMRI cases were analyzed by using PI-RADS version 1 and version 2. Conclusion was

considerable: in patients who underwent radical prostatectomy, an abnormal mpMRI is highly predictive (95% PPV) of significant prostate cancer, with an index lesion concordance of 75%. There has been a significant improvement in accuracy after the adoption of PI-RADS version 2 technical specifications and reporting criteria [22].

The moderate correlation of PI RADS with Gs was defined in Heister et al. study concluding low risk Pc have lower PI RADS sum scores than intermediate and high-risk tumors [23]. Recently conducted prospective study also found moderate correlation of PI RADS with Gs(Kendall Tau 0.354). In this study methods, especially inclusion criteria were different to our study [13]. In contradistinction to these results in their retrospective study Slaoui et al. concluded that PI RADS score was not associated with significant differences regarding Gleason score distribution within target. Methods were similar to our study; exact match of Gs in pre and postoperative biopsies were found in 62%, which is lower than we observed in our series-88,31%. In their series all diagnosed cancers assigned with PI RADS 3 corresponded to Gs 7 [15]. In our research we had different findings: PI RADS 3 lesions were defined as Gs6(3+3) n=4; Gs 8(4+4) n=2 and Gs8(5+3) n=1.

Research of Katz et al. revealed that mpMRI and PI RADS alone are not sufficient to determine clinically significant prostate cancer since both high- and low-grade tumors were found in PI RADS 4 and 5 [11]. To overcome related problems, we placed emphasis on PI RADS sum score calculation, by summing up each single score and this enhances credibility of diagnostic test.

With regards to PI RADS 3, defined as equivocal cancer suspicion, could lead to certain management challenges and cause uncertainty in PI RADS diagnostic accuracy. To solve this problem Junker et al. in their article recommended to lift the threshold between PI RADS 2 and from sum score levels ≥ 7 to ≥ 8 [8]. This issue still remains in contention. In our study 54 patients were assigned to PI RADS 3, 47 patients were cancer negative in preoperative biopsies and only 7 of them had positive biopsies; these falsely high initial PI RADS scores mainly corresponded to the presence of benign adenomas. Need of new approaches is obvious to reduce this false positive rate-difficulties with MR differentiation between benign and malignant lesions. This observation emphasizes the importance of PI RADS 3 as reported previously [24].

Latest work of Ono et al. showed that from following parameters: Age, prostate volume, transition zone volume, and mean and minimum apparent diffusion coefficients only the minimum apparent diffusion coefficient value (odds ratio: 0.994; $p < 0.001$) was an independent predictor of clinically significant prostate cancer. Minimum ADC provided additional value to indicate the presence of clinically significant prostate cancer in the transition zone for the PI RADS 4/5 lesions. This will be valuable data to consider the need for subsequent biopsies in patients with Prostate Imaging Reporting and Data System 4/5 lesions and an initial negative targeted biopsy [25].

Prostate biopsy Gs upgrading remains a challenge for clinicians managing localized Pc [5]. In our study out of 153 patients who underwent preoperative TRUS (n=137) biopsy and MRI/Ultrasound fusion guided biopsy(n=16), 18 patients (11.7%) all with history of TRUS biopsy showed discrepancies with Gleason score upgrade.

The need for improved understanding of the role of pre-biopsy mpMRI is obvious. MpMRI with PI RADS risk stratification system has potential to bridge this gap existing between pre and postoperative biopsies, in this most important stage this technique could avoid unnecessary treatment reducing side effects through precise approach thus improving quality of life with it. In summary our findings indicate a significant advantage of using the prediction model as PI RADS. We envisage that the growing field of artificial intelligence, machine learning and scrupulous approach of radiologists may take us closer to precise prediction of final Gs by mpMRI.

Limitations.

In our study PI RADS sum score of several cases were generated retrospectively, subsequently and uniformly after collection of whole radiological data while overall PI RADS scores were calculated consecutively, this might have led to some verification bias, however, sum scores were calculated independently, radiologists were blinded to morphological reports. Additionally, this is a single centre study; performance of our model needs further validation in an external data set. Further multicentre studies with data based on larger sample size will be necessary to assess contribution of mpMRI to clinical practice.

Conclusion.

PI RADS demonstrated a highly positive correlation with Gleason scores. It showed strong relation with histopathological adverse prognostic features. mpMRI with PI RADS risk stratification system is a reliable approach in prediction of Pc grade in preoperative period with high accuracy. Considering discrepancy between pre and postoperative Gleason grades which still remains as challenge PI RADS has capacity to avoid unnecessary invasion, providing precise treatment strategy, especially for low-risk tumors.

Conflict of interest disclosure.

Authors declare no potential conflicting interests related to this paper.

REFERENCES

1. WHO. Source: Globocan 2020. 2020.
2. Pierorazio PM, Walsh PC, Partin AW, et al. Prognostic Gleason grade grouping: Data based on the modified Gleason scoring system. BJU Int. 2013;111.
3. Presti JC. Prostate biopsy: current status and limitations. Rev Urol. 2007.
4. Moosavi B, Flood TA, Al-Dandan O, et al. Multiparametric MRI of the anterior prostate gland: Clinical-radiological-histopathological correlation. 2016;71.
5. Alqahtani S, Wei C, Zhang Y, et al. Prediction of prostate cancer Gleason score upgrading from biopsy to radical prostatectomy using pre-biopsy multiparametric MRI PIRADS scoring system. Sci Rep. 2020;10.
6. Bai W, Fadil Y, Idrissi O, et al. The correlation between the

gleason score of the biopsy and that of the prostatectomy patch. 2021;63.
7. Panebianco V, Barchetti F, Sciarra A, et al. Multiparametric magnetic resonance imaging vs. standard care in men being evaluated for prostate cancer: A randomized study. Urol Oncol Semin Orig Investig. 2015;33.
8. Junker D, Schäfer G, Edlinger M, et al. Evaluation of the PI-RADS scoring system for classifying mpMRI findings in men with suspicion of prostate cancer. Biomed Res Int. 2013;2013.
9. Röthke M, Blondin D, Schlemmer HP, et al. PI-RADS classification: Structured reporting for MRI of the prostate. RöFo - Fortschritte auf dem Gebiet der Röntgenstrahlen und der Bildgeb Verfahren. 2013.
10. Nilsson P, Ströberg P. Are TRUS-guided prostate biopsies in clinical practice robust enough to make a correct assessment of the surgical strategy in prostatectomies? Poor correlation between preoperative prostate biopsies and postoperative specimens. Scand J Urol. 2019;53.
11. Katz A, Liu C, Kosinski KE. Histopathologic correlation of PI-RADS V.2 lesions on 3T multiparametric prostate MRI. J Clin Oncol. 2016;34.
12. Kızılay F, Çelik S, Sözen S, et al. Correlation of Prostate-Imaging Reporting and Data Scoring System scoring on multiparametric prostate magnetic resonance imaging with histopathological factors in radical prostatectomy material in Turkish prostate cancer patients: a multicenter study of the Urooncology Association. Prostate Int. 2020;8.
13. Parameswaran M, Bhuvanagiri A, Kannan S, et al. Correlation between Gleason score and PIRADS score on mpMRI –initial experience. Eur Urol Open Sci. 2020;21.
14. Bastian-Jordan M. Magnetic resonance imaging of the prostate and targeted biopsy, Comparison of PIRADS and Gleason grading. J Med Imaging Radiat Oncol. 2018;62.
15. Slaoui H, Neuzillet Y, Ghoneim T, et al. Gleason score within prostate abnormal areas defined by multiparametric magnetic resonance imaging did not vary according to the pirads score. Urol Int. 2017;99.
16. Koo JH, Kim CK, Choi D, et al. Diffusion-weighted magnetic resonance imaging for the evaluation of prostate cancer: Optimal B value at 3T. Korean J Radiol. 2013;14.
17. Mazaheri Y, Akin O, Hricak H. Dynamic contrast-enhanced magnetic resonance imaging of prostate cancer: A review of current methods and applications. World J Radiol. 2017.
18. Turkbey B, Rosenkrantz AB, Haider MA, et al. Prostate Imaging Reporting and Data System Version 2.1: 2019 Update of Prostate Imaging Reporting and Data System Version 2. 2019;76.
19. Beksac AT, Cumarasamy S, Falagario U, et al. Multiparametric Magnetic Resonance Imaging Features Identify Aggressive Prostate Cancer at the Phenotypic and Transcriptomic Level. J Urol. 2018;200.
20. Hectors SJ, Cherny M, Yadav KK, et al. Radiomics features measured with multiparametric magnetic resonance imaging predict prostate cancer aggressiveness. J Urol. 2019;202.
21. Rayn KN, Bloom JB, Gold SA, et al. Added Value of Multiparametric Magnetic Resonance Imaging to Clinical Nomograms for Predicting Adverse Pathology in Prostate Cancer. J Urol. 2018;200.
22. Kam J, Yuminaga Y, Krelle M, et al. Evaluation of the accuracy of multiparametric MRI for predicting prostate cancer pathology and tumour staging in the real world: an multicentre study. BJU Int. 2019;124.
23. Hiester A, Arsov C, Quentin M, et al. 1057 Correlation of the PI-RADS score and the Gleason grade in prostate cancer lesions after targeted in bore MR-biopsy. Eur Urol Suppl. 2014;13.
24. Osses DF, Arsov C, Schimmöller L, et al. Equivocal pi-rads three lesions on prostate magnetic resonance imaging: Risk stratification strategies to avoid mri-targeted biopsies. J Pers Med. 2020;10.
25. Ono A, Hashimoto T, Shishido T, et al. Clinical value of minimum apparent diffusion coefficient for prediction of clinically significant prostate cancer in the transition zone. International journal of clinical oncology. 2023;28:716-723.