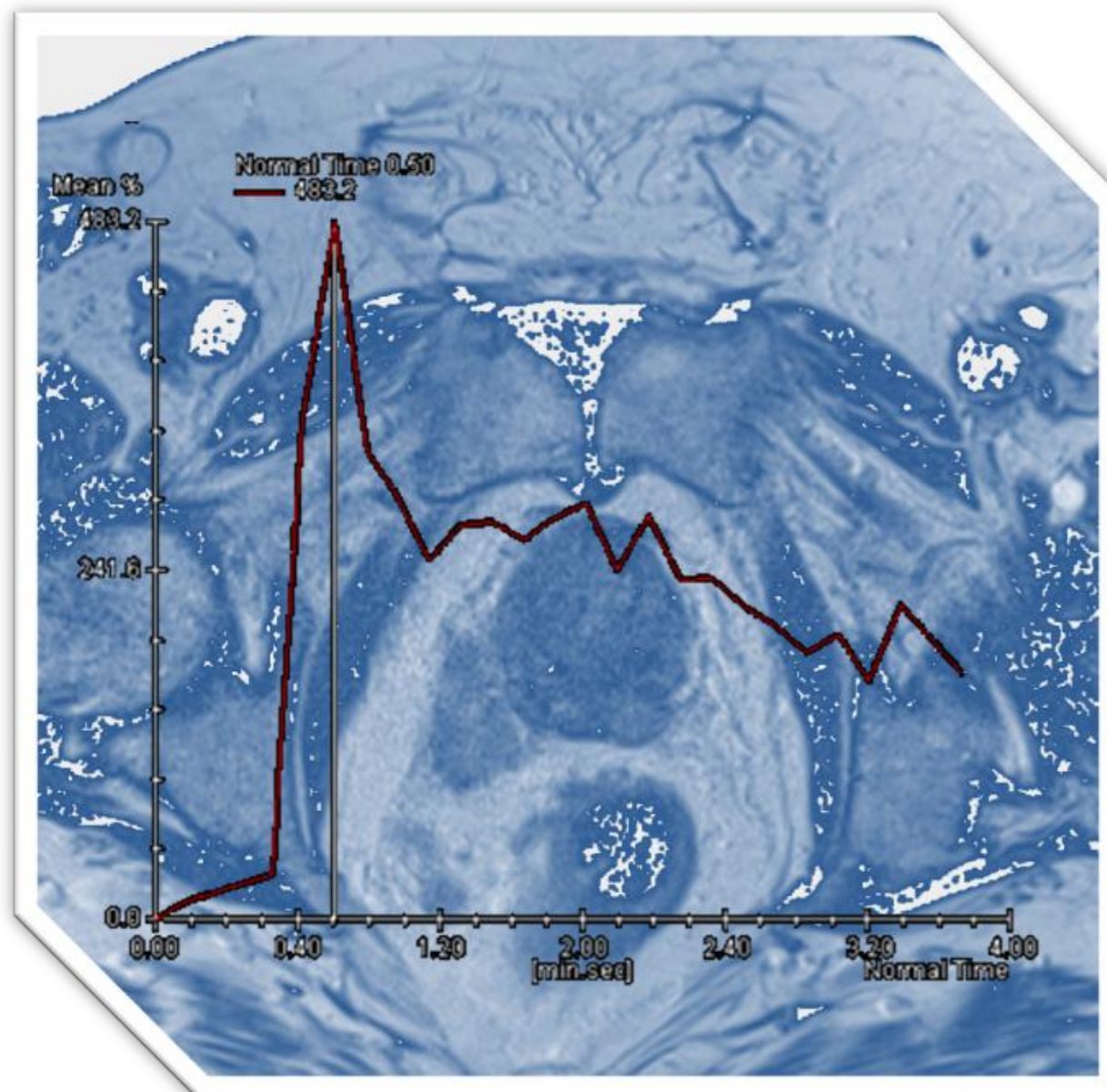


# Prostate Cancer: Dynamic Contrast-enhanced MR Imaging

Lopes Dias, João; Fialho, Joana; Alves, Pedro; Almeida, Cristina; Cordeiro, Ana Rosa; Mateus Marques, Rui  
Serviço de Radiologia – CHLC – Hospital de S. José



The tumor angiogenesis and the characteristic surrounding interstitial environment can be used as a diagnostic marker of disease, since it changes the tissue's enhancement pattern after contrast administration. The cancerous tissue has an increased number of vessels due to the production and release of angiogenic factors (vascular permeability factor or vascular endothelial growth factor) and its permeability is greater than normal vessels.

DCE MR imaging provides direct depiction of tumor vascularity and may avert the use of an endorectal coil. A full dose (0.1 mmol/ kg) of gadolinium is generally injected at 3 mL/sec, and serial 3D acquisitions are obtained every 2–5 seconds through the prostate. That way, it is possible to display quantitative kinetic parameters reflecting contrast washin and washout, including onset time, time to peak enhancement, peak enhancement, relative peak enhancement (comparing to normal tissue), and washout time.

Tumors often demonstrate early nodular enhancement before the rest of the parenchyma and early washout of signal intensity, a pattern which is highly predictive of prostate cancer despite being non pathognomonic. Engelbrecht et al demonstrated that the relative peak enhancement was the most accurate perfusion parameter for cancer detection in the peripheral zone and central region of the gland. The detection of areas of enhancement on early postcontrast images (within the first 30–60 seconds after contrast material injection) may also be used to detect cancer.

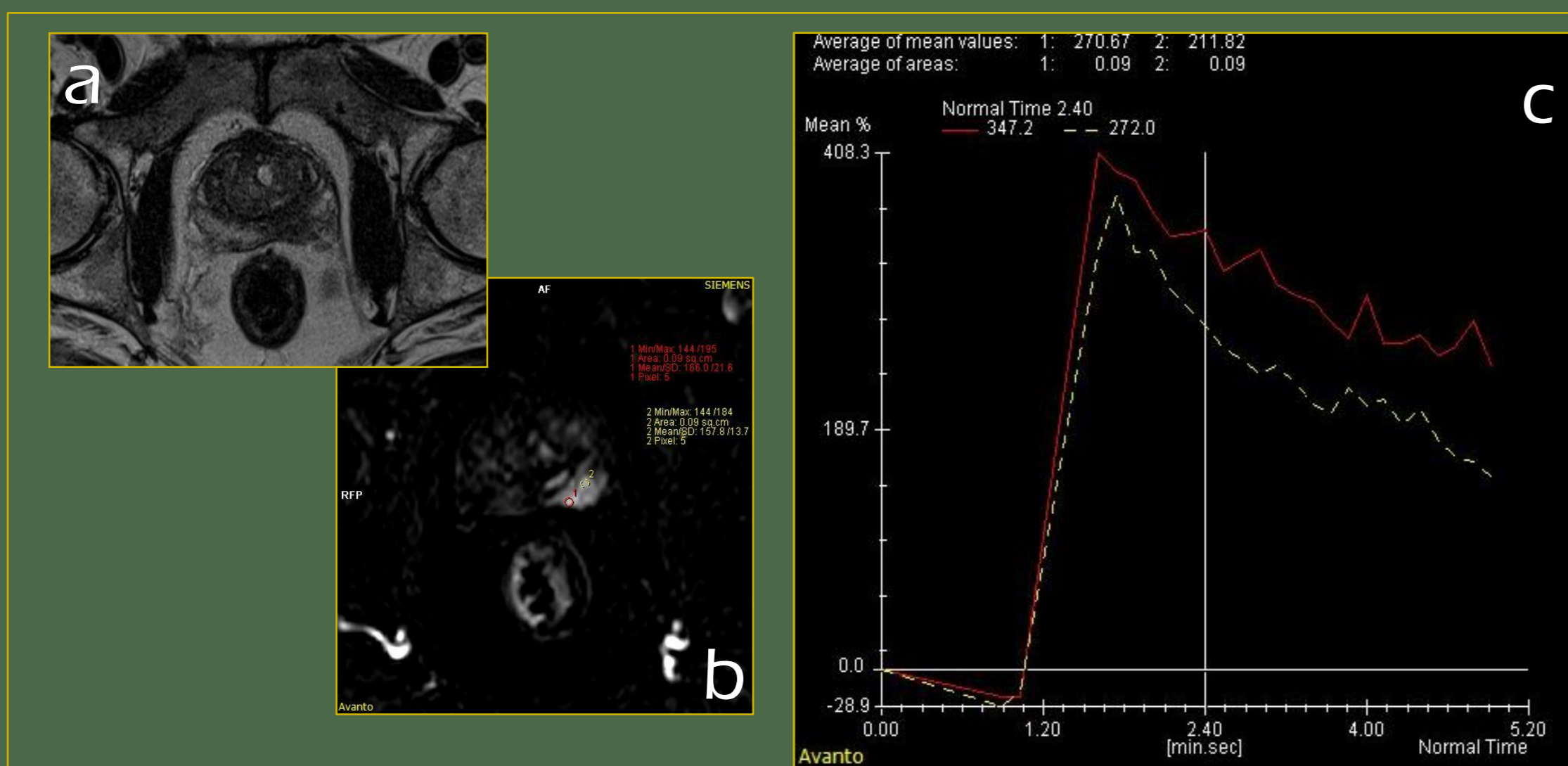


Fig. 1. Images in a 73-year-old man with PSA level of 18.4 ng/mL and biopsy-proved adenocarcinoma in with Gleason score of 7. Axial T2-WI (c) show a 10 mm hypointense suspicious nodule within the left peripheral zone. Post-gadolinium T1-WI (b) demonstrates enhancement of the tumor focus and the placement of two regions of interest from which were obtained time–signal intensity curves (x-axis, time in seconds; y-axis, signal intensity in mean percentage) (a), showing fast and high peak enhancement followed by a marked washout.

DCE was considered a useful technique for cancer detection and tends to obtain higher sensitivity values than that of T2WI. One study reported sensitivity of 73% and specificity of 81% for dynamic contrast-enhanced MRI at 1.5 T in defining prostate cancers and another found comparable values at 3T. However, it is important to note that some prostate tumors are only mildly or moderately hypervascular and thus are not detectable through this technique. Moreover, smaller and low grade tumors may not demonstrate abnormal enhancement on DCE-MRI.

DCE MRI can also be used for determining the effectiveness of hormone deprivation therapy which tends to reduce the tumor permeability and to change the tissue washout pattern.

## LIMITATIONS

DCE MRI has an important limitation (Fig.2): the insufficient depiction of transitional zone cancer in patients with hypervascular benign prostatic hyperplasia because abnormal enhancement patterns may be seen in both tumors and benign nodules.

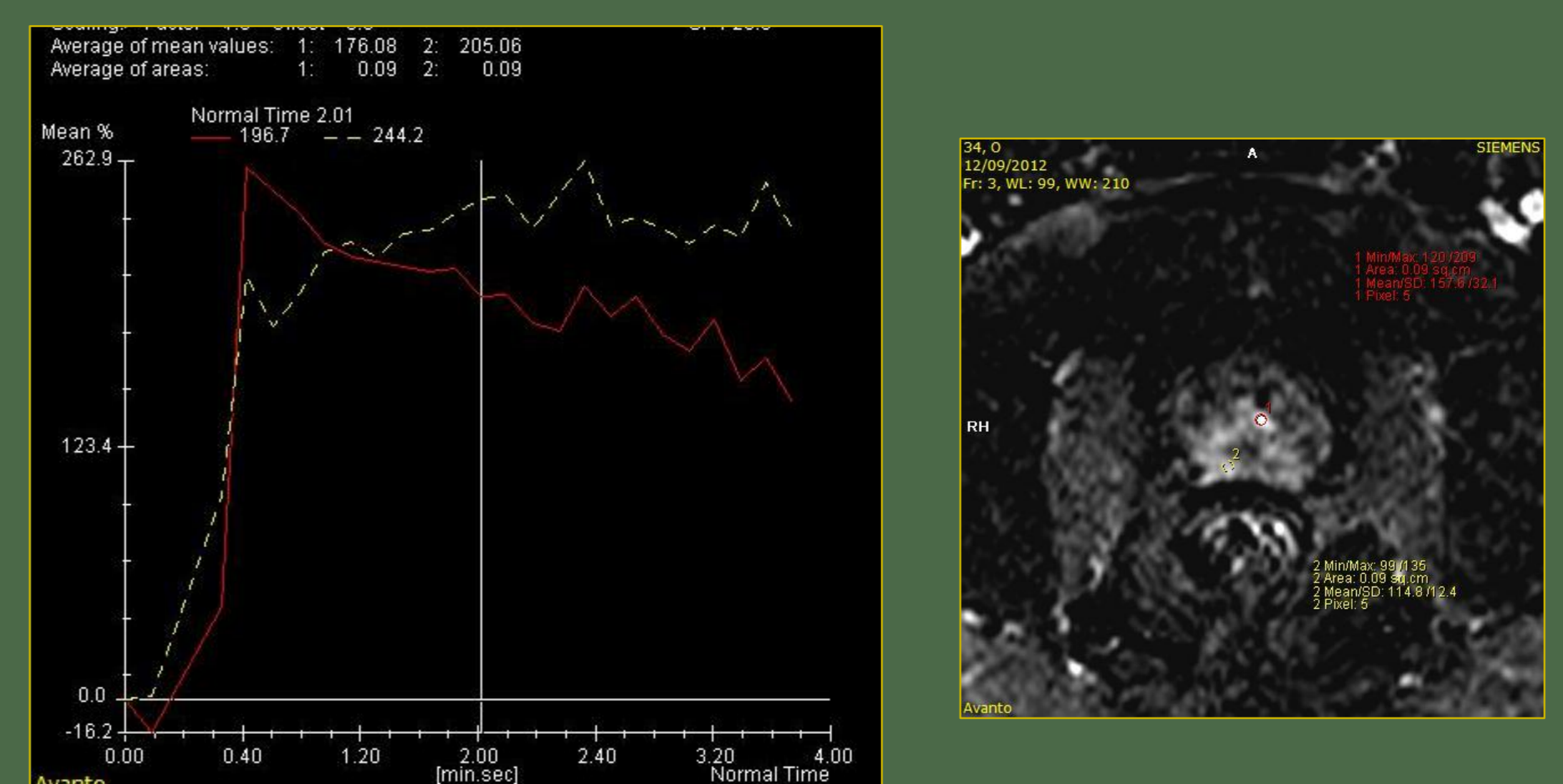


Fig. 2: Contrast-enhancement comparison between two different areas: (Red) Early nodular enhancement and early washout of signal intensity, in the central gland, probably referring to a benign adenoma. (Yellow) High contrast- enhancement without relevant washout in a peripheral area, unsuspicious for malignancy.

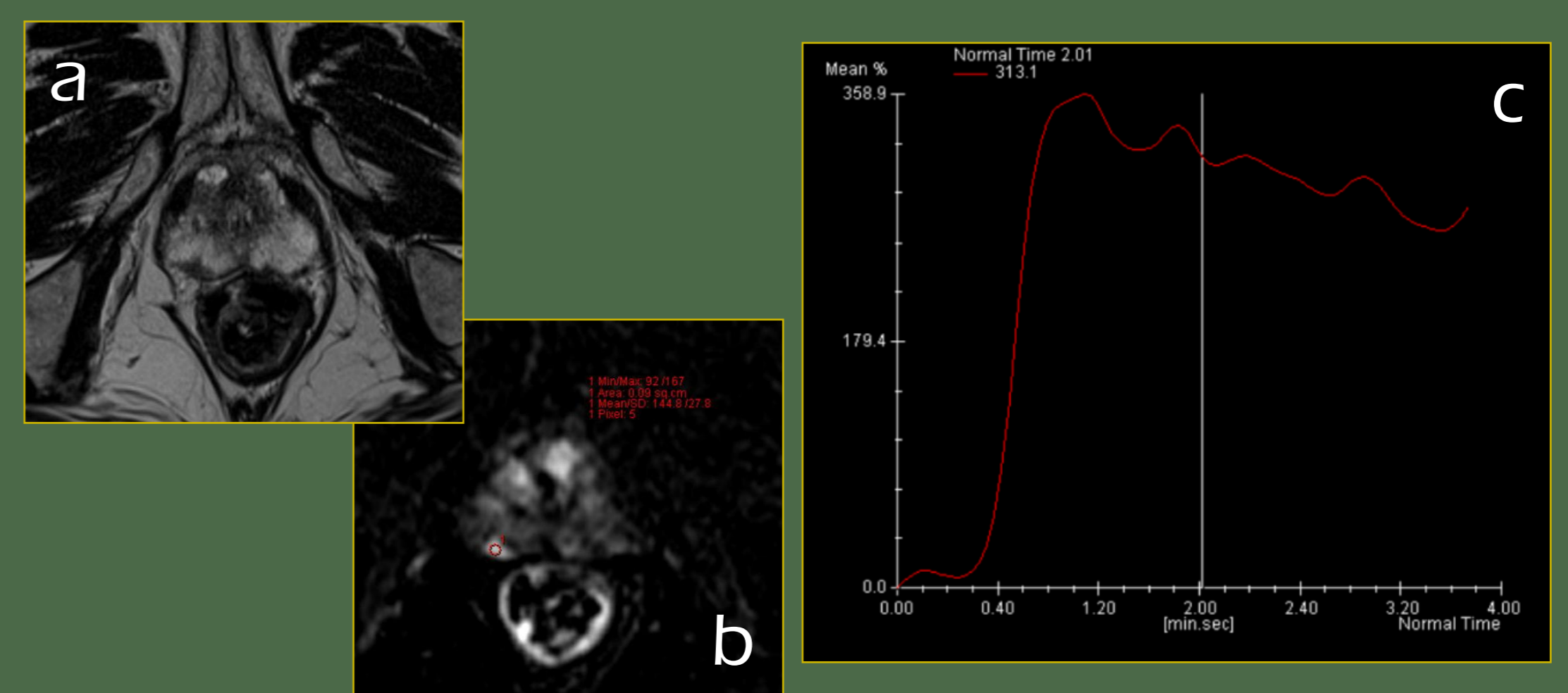


Fig. 3 Images in a 76-year-old man with persistent high PSA level of 11 ng/mL and an initial negative biopsy. Axial T2-WI (a) show a 11 mm hypointense nodule within the right peripheral zone. The suspicious area demonstrates early enhancement on post-gadolinium T1-WI (b) and the obtained time–signal intensity curve (x-axis, time in seconds; y-axis, signal intensity in mean percentage) (c) shows a moderate washout following the fast and high peak enhancement. The second biopsy was ultrasound-guided to the suspicious nodule and revealed an adenocarcinoma in with Gleason score of 6.

Some studies like that of Kim et al demonstrated that dynamic contrast-enhancement analysis was more accurate for the detection of prostate cancer in the peripheral zone than conventional T2-weighted imaging alone.

- Ravizzini G, Turkbey B, Kurdziel K, Choyke PL. New horizons in prostate cancer imaging. *European Journal of Radiology*. 2009;70(2):212–26.
- Turkbey B, Albert PS, Kurdziel K, Choyke PL. Imaging localized prostate cancer: current approaches and new developments. *American Journal of Roentgenology*. 2009;192(6):1471–80.
- Eberhardt SC, Leibell SA, Scardino PT. Imaging Prostate Cancer: a multidisciplinary perspective. *Radiology*. 2007;243(1):28–53.
- Chelikh AB, Gironi N, Colombel M, et al. Evaluation of T2-weighted and dynamic contrast-enhanced MRI in localizing prostate cancer before repeat biopsy. *European Journal of Radiology*. 2009;10(3):777–8.
- Choi YJ, Kim JK, Kim N, et al. Functional MR imaging of prostate cancer. *Radiographics*. 2007;27(1):63–75.
- Claus FG, Hricak H, Hattery RR. Pretreatment Evaluation of Prostate Cancer: Role of MR Imaging and H MR Spectroscopy. *Radiographics*. 2004;24:167–180.
- Engelbrecht MR, Huisman HJ, Laheij RJJ, et al. Discrimination of Prostate Cancer from Normal Peripheral Zone and Central Gland Tissue by Using Dynamic Contrast-enhanced MR Imaging. *Radiology*. 2009;229(1):248–254.
- Alonzi R, Padhani AR, Allen C. Dynamic contrast enhanced MRI in prostate cancer. *European Journal of Radiology*. 2007;63(3):335–50.
- Turkbey B, Ravizzini G, Mani H, et al. 3T MR Imaging of the Prostate Gland: What the Urologist Needs to Know. *North.90*.
- Kim JK, Hong SS, Choi YJ, et al. Wash-in rate on the basis of dynamic contrast-enhanced MRI: usefulness for prostate cancer detection and localization. *Journal of magnetic resonance imaging*. 2005;22(5):639–46.
- Jager GJ. Dynamic TurboFLASH Subtraction Technique for Contrast-enhanced MR Imaging of the Prostate: Correlation with Histopathologic Results. *Radiology*. 1997;203:645–652.