

Impact of forced diuresis at two different time points on Pelvic imaging in Prostatic Carcinoma with ⁶⁸Ga-PSMA PET/CT

Shobhana Raju, Akshima Sharma, Anshul Sharma, Anil Kumar Pandey, C. S. Bal, Rakesh Kumar



Introduction

- ⁶⁸Ga-PSMA PET/CT targeting prostate specific membrane antigen (PSMA) has emerged as a non-invasive diagnostic modality for prostate carcinoma (PCa), especially in staging of intermediate and high risk PCa and to rule out recurrence following primary therapy.
- Both for primary and secondary staging of recurrence, ⁶⁸Ga-PSMA PET/CT has a pivotal role to play. All these significances in the staging of PCa are limited by the physiological tracer excretion in the bladder and pelvic ureters.
- The tracer accumulation in the bladder obscures the visualisation of the EPE (extraprostatic extension) and SVI (Seminal vesicle invasion) and that in the ureters mimic the LNM (Lymph nodal metastasis).
- This lead to interventions reducing the urinary activity and facilitating the better visualisation of tumour uptake, namely oral hydration, intravenous furosemide and early imaging protocols.
- Diuretics are the best suited for this purpose as they enhance the urinary elimination of the radiotracer without interfering with the tumour uptake of ⁶⁸Ga-PSMA.
- Furosemide, a loop diuretic gives maximum diuresis 30 min after intravenous injection, is best suited for use with ⁶⁸Ga-PSMA with a half-life of 68 min.
- This allows a sufficient imaging time window, before any significant biological decay of radiotracer, for reduction of bladder activity.
- The most common diuretic protocol in clinical practice is ⁶⁸Ga-PSMA whole-body scan followed by furosemide injection and a delayed post-diuretic pelvic scan.
- Although the existing protocol gives good quality images for prostate cancer, it is not without limitations.
- In nuclear medicine department like ours, the per day patient load is high and many a time it becomes difficult to spare time for post furosemide delayed imaging for each PSMA PET/CT patients.
- Moreover, physicians injecting radiotracer has to be exposed to radiation twice and also, patients have to wait longer for completion of procedure.
- Thus, there is need for a protocol which can solve the above-mentioned issues and at the same time maintain the image quality.
- In the present study we compared diagnostic quality of ⁶⁸Ga-PSMA PET/CT imaging using two furosemide protocols (first is the existing protocol and in second protocol lasix was injected along with radiotracer) in two different groups of patients.

Materials and Methods

- A total of 55 patients with histopathologically proven prostate cancer (PCa) were retrospectively enrolled in the study.
- Out of 55, 31 patients were of group 1 (median age: 66 years, Range 44-78 years) in which furosemide injection was given after completion of whole body ⁶⁸Ga-PSMA PET/CT scan and 24 patients were in group 2 (Median age: 63.5 years, range: 50-82 years) in which it was given along with the ⁶⁸Ga-PSMA injection.
- In both groups, an initial time point scan (T0 scan) and a delayed time point scan (T1 scan) was done.
- The images were analyzed qualitatively (by visual inspection) as well as quantitatively (by evaluating SUVmax, target to background ratio (T:B)) focusing on four structures: bladder, prostatic lesions, seminal vesicle involvement and ureters.
- For visual inspection three point scoring system was used in which prostatic lesion and seminal vesical invasion (SVI) visualization were analyzed using one scoring system (0-negative, 1-equivocal, 2-positive) and bladder and ureteric activity washout was analyzed using another scoring system (0-radioactivity less than background, 1-radioactivity equal to background, 2-radioactivity more than background).
- The visual assessment scores and semi-quantitative variables at T0 as well as T1 scans were compared among the two groups of patients using Chi-square test and Mann-Whitney U test, respectively.

Results

- Qualitatively, prostatic lesions and SVI were clearly visible in all patients(100%) at T0 scan in group 2 as compared to 80.64% and 25.80% patients, respectively in group 1.
- Quantitatively there was no statistically significant difference between the SUVmax and T:B of prostatic lesion and SVI in both the groups at two time points ($p>0.05$).
- Early furosemide injection caused a washout of the urinary bladder radiotracer concentration in significantly higher number of patients in group 2 as compared to group 1 (62.5% Vs 6.45% patients, $p<0.001$).
- This was substantiated quantitatively by the bladder activity at T0 being significantly lesser in the group 2 as compared to group 1 (SUVmax 5.45 v/s 17.17; $p<0.01$).
- Also, group 2 had less focal interference by ureteric activity than group 1(1/24 patients Vs 7/31patients, $p=0.024$).
- Quantitatively also there was significant clearance of radiotracer activity from the ureters in the group 2 compared group 1 (SUVmax: 9.28 v/s 3.09, $p=0.002$).

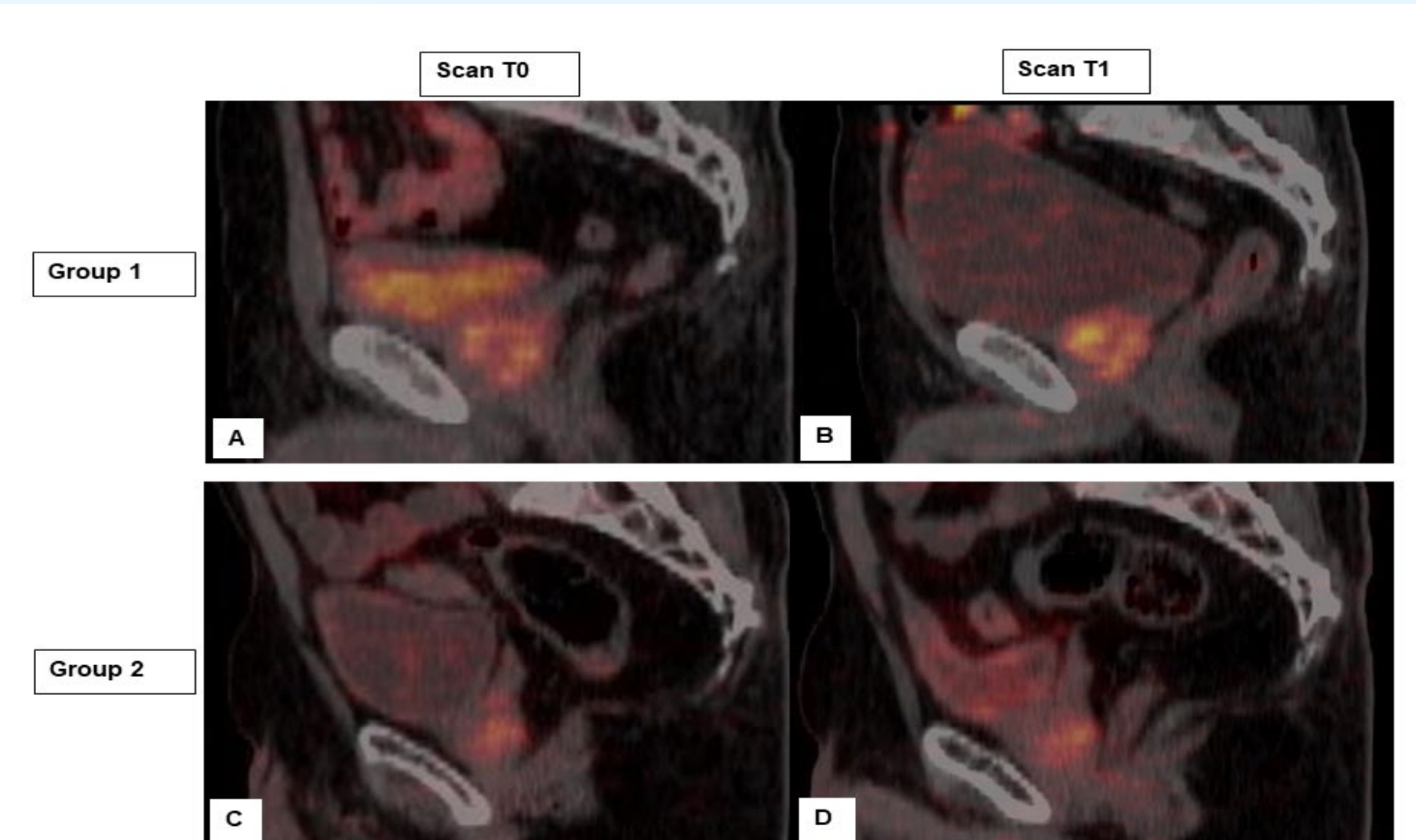


Figure 1: ⁶⁸Ga-PSMA PET/CT images showing the visualization of radiotracer uptake in prostate at T0 and T1 scans in Group 1 and Group 2; It can be seen that radiotracer uptake in prostate became more evident in T1 scan after bladder activity washout in Group 1. On the contrary, in group 2, prostatic uptake becomes evident in T0 scan due to early washout of activity from bladder eliminating the requirement of delayed scan

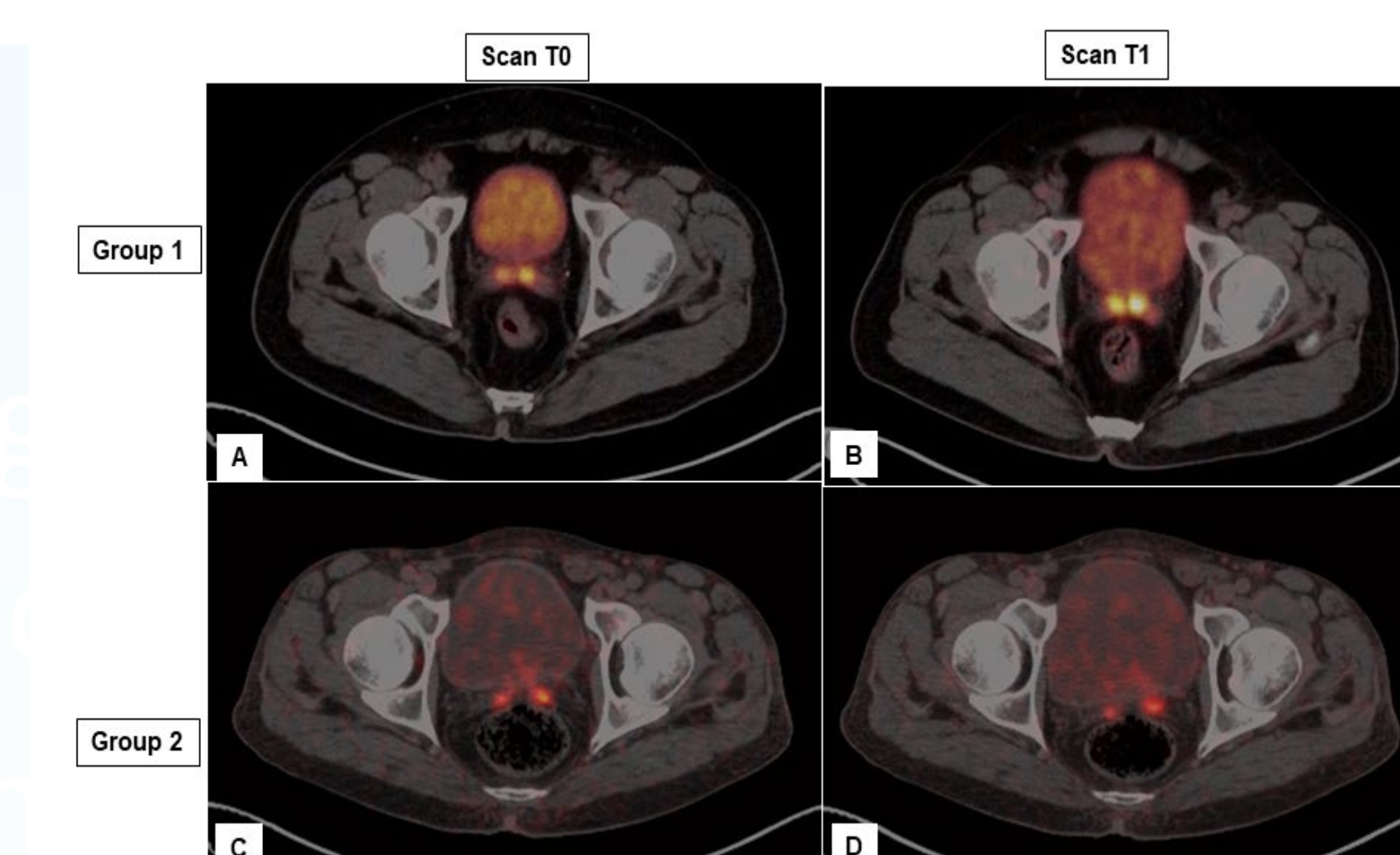


Figure 2: ⁶⁸Ga-PSMA PET/CT images showing the visualization of seminal vesicle involvement at T0 and T1 scans, in Group 1 (A) & (B) and Group 2 (C) & (D), respectively. In group 2, due to the early washout of radiotracer, seminal vesicle involvement is clearly evident in T0 scan

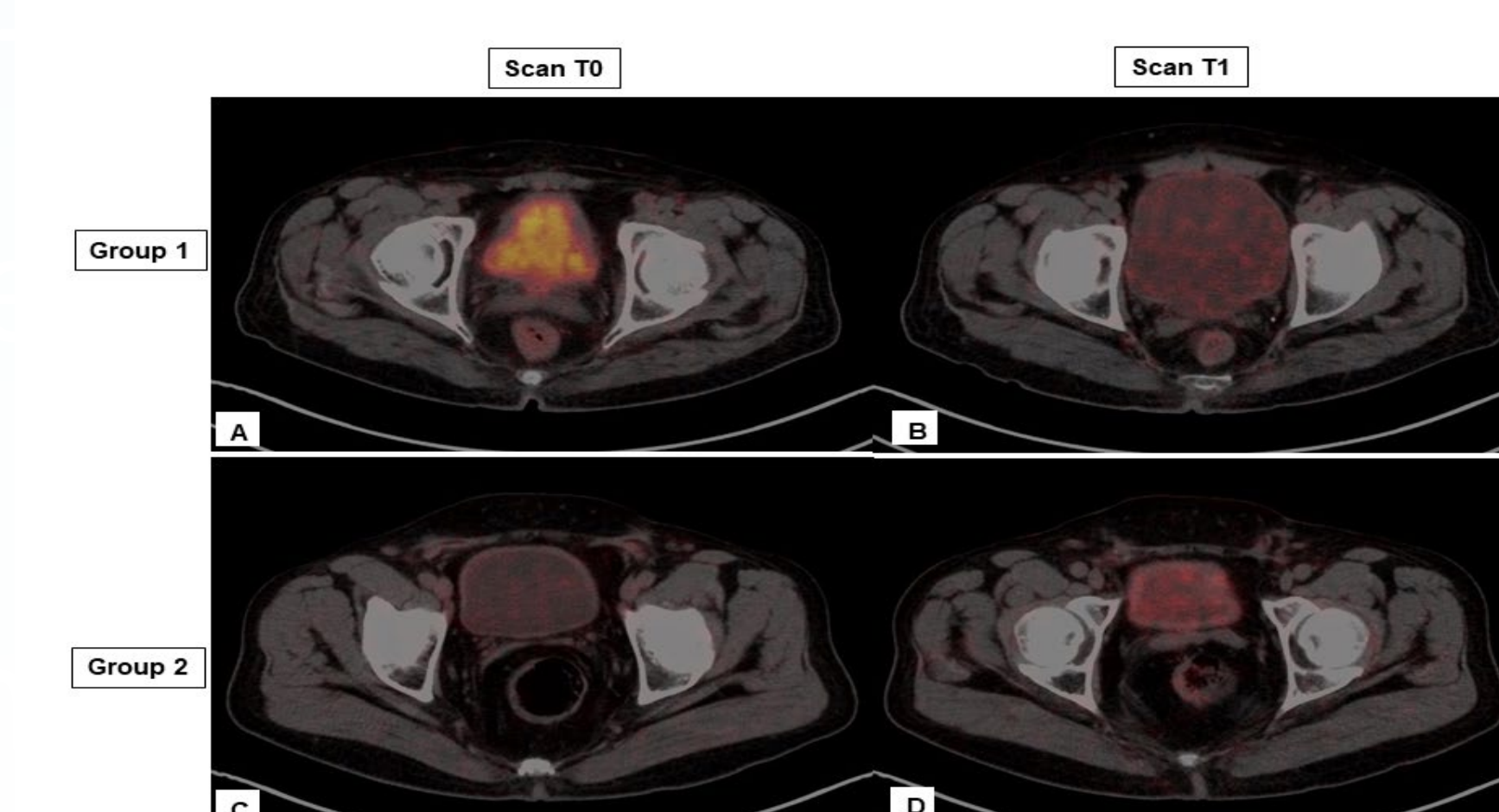


Figure 3: ⁶⁸Ga-PSMA PET/CT images showing radiotracer concentration in urinary bladder at T0 and T1 scans in Group 1 (A) & (B) and in Group 2 (C) & (D), respectively. It can be seen that there is a significant washout of radiotracer from urinary bladder at T0 scan (initial time point) in Group 2 (when furosemide is injected along with radiotracer injection) whereas, in Group 1 (when furosemide is injected after first scan) one has to wait for delayed scan (post-furosemide view) for bladder radioactivity clearance

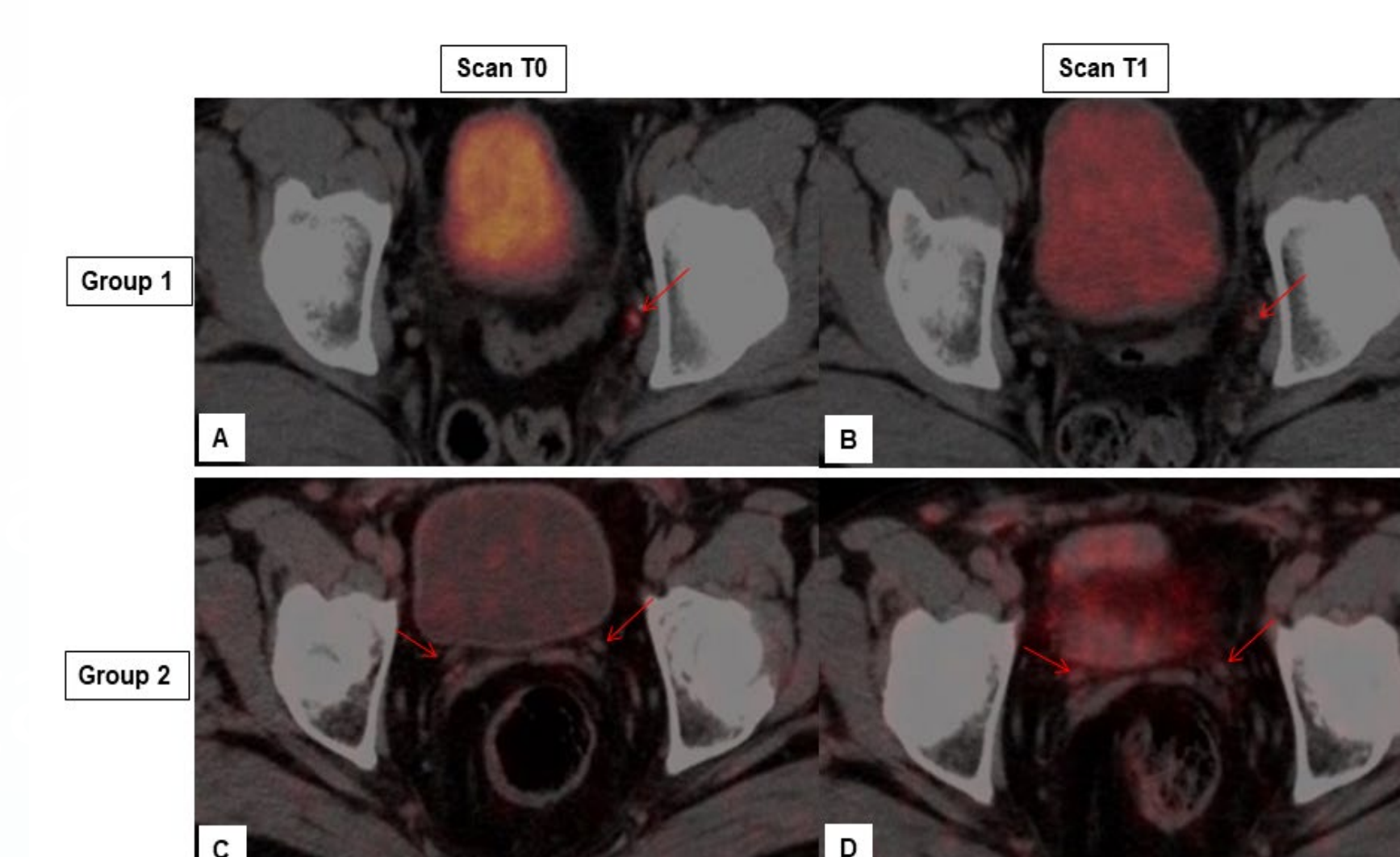


Figure 4: ⁶⁸Ga-PSMA PET/CT images; A) & B) showing T0 and T1 scans, respectively in Group 1. There is a focal radiotracer uptake (marked with arrow) at T0 which gets cleared at T1, it was actually the radiotracer uptake in the ureter which got cleared after furosemide injection; C) & D) showing T0 and T1 scans, respectively in Group 2. The clearance in the ureteric radiotracer activity was achieved at T0 scan whereas in T1 scan the activity slightly increased in right ureter

Discussion

- An initial washout of the tracer from the bladder facilitated confident reporting of the prostatic lesion and SVI in the patients given simultaneous furosemide injection at an initial timepoint itself.
- Whereas the group in which furosemide was given after WBS, high activity was noted in the bladder in the initial timepoint which interfered with the interpretation of the prostatic and seminal vesicle lesion and this was cleared in the delayed post furosemide images making interpretation easy.
- The high activity in the bladder interfering with interpretation of the SVI was washed out in the initial images in the simultaneous furosemide protocol making the confident reporting of the SVI possible.
- Another observation in our study was that the washout of the intense tracer activity from the ureters reduced the number of focal activities interfering with LNM detection.
- Derlin et al in his study showed that the protocol with simultaneous injection of radiotracer and furosemide reduced the focal and linear ureteric uptake in the ureters significantly.
- Contrary to our expectation, only 2 patients found to have problem in lying down during the acquisition due to urgency for voiding.
- Limitations of the study include the retrospective design and small sample size with a heterogenous patient population.
- Another limitation is that to determine the effect of ideal timing of the furosemide injection, only two time points were considered for evaluation in both the protocols.

Conclusion

The simultaneous furosemide and ⁶⁸Ga-PSMA injection can reduce the urinary excretion of the tracer and improve the diagnostic confidence of prostatic lesion, SVI and lymph nodal metastasis, along with reducing the scanning time and radiation burden. Therefore this protocol can be used as an effective alternative to the present protocol of delayed furosemide injection.