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Original Research Article

Diagnostic Accuracy of Abdomino-Pelvic Contrast Enhanced CT Scan to Detect Muscle Invasion in Bladder Cancer

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Conflict of interest: Nil

Abstract:

Background: The standard imaging work-up for gross hematuria and suspected urothelial tumor has shifted from excretory urography to cross-sectional modalities such as ultrasonography (USG), CT, and magnetic resonance (MR) imaging. Cystoscopy and biopsy are the standard of reference for bladder evaluation. Accurate and effective imaging to determine the stage of the primary tumor and/or nodal metastasis in patients with bladder carcinoma is crucial in deciding whether patients should be treated conservatively, or with surgical or radio chemotherapeutic treatment. Regarding the primary tumor, the question of depth of invasion is crucial as the prognosis is far worse for muscle invasive disease (T2, T3, T4). We conducted this study to investigate the diagnostic accuracy of contrast enhanced CT scan compared to histopathology post Trans Urethral Resection of Bladder Tumor (TURBT) in determining muscle invasive disease.

Methods: This single centre retrospective study was conducted in the Department of Urology, Government Medical College, Thiruvananthapuram, India. All patients who underwent TURBT (Transurethral Resection of Bladder Tumour) surgery during the period from September 2019 to September 2021 under the department of Urology were enrolled in the study. Exclusion criteria were patients with allergy to contrast material used in CT and those patients who were in renal failure. There were 110 cases in total.

Results: Abdominopelvic CT scan had 88.37% sensitivity to detect muscle invasion as compared to histopathology. Fair agreement exists between histopathology and abdomino-pelvic contrast enhanced CT findings with kappa of 0.213 and p value of 0.009. Overall concordance rate was 62.73% and overall discordance rate was 37.27% between histopathology and CT findings. Age and visible tumour in cystoscopy were significant risk factors for muscle invasion. With the increase in age(years), risk of muscle invasion significantly decreased with odds ratio of 0.964(0.929 to 1). Patients with visible tumour in cystoscopy had significantly high risk of muscle invasion with odds ratio of 31.315(5.458 to 179.678). On performing multivariate regression, visible tumour in transurethral cystoscopy was found to be a significant independent risk factor of muscle invasion with adjusted odds ratio of 32.502.

Conclusion: Through this study we find that abdominopelvic CT scan had 88.37% sensitivity to detect muscle invasion as compared to histopathology which is the gold standard for the same. Hence abdominopelvic CT scan can be utilised to reliably screen for muscle invasion in bladder carcinoma and may be helpful in staging bladder carcinoma prior to resection and

biopsy itself, although further studies using larger numbers of patients are required in future to substantiate the same.

Keywords: muscle invasion, bladder cancer, abdomino-pelvic CT scan

Introduction

Primary bladder neoplasms account for 2%–6% of all tumours, with bladder cancer ranked as the fourth most common malignancy. Ninety-five percent of bladder neoplasms arise from the epithelium; the most common subtype is urothelial carcinoma, which accounts for 90% of cases. Squamous cell carcinoma accounts for 2%–15%, with rates varying widely according to geographic location. Adenocarcinoma (primary bladder, urachal, or metastatic) represents less than 2%. Bladder cancer typically occurs in men aged 50–70 years and is related to smoking or occupational exposure to carcinogens. The standard imaging work-up for gross hematuria and suspected urothelial tumor has shifted from excretory urography to cross-sectional modalities such as ultrasonography (USG), CT, and magnetic resonance (MR) imaging. Cystoscopy and biopsy are the standard of reference for bladder evaluation, but imaging is important for accurate staging and treatment planning. Accurate and effective imaging to determine the stage of the primary tumor and/or nodal metastasis in patients with bladder carcinoma is crucial in deciding whether patients should be treated conservatively, or with surgical or radio chemotherapeutic treatment. Regarding the primary tumor, the question of depth of invasion is crucial as the prognosis is far worse for muscle invasive disease (T2, T3, T4). We conducted this study to investigate the diagnostic accuracy of contrast enhanced CT scan compared to histopathology post Trans Urethral Resection of Bladder Tumor (TURBT) in determining muscle invasive disease.

Objective

To determine the diagnostic accuracy of abdomino-pelvic contrast enhanced CT scan as compared to histopathological examination, to detect muscle invasion in bladder cancer patients.

Methodology

Study Design:

Single centre, retrospective study

Study Setting:

Department of Urology, Government Medical College, Thiruvananthapuram, Kerala, India.

Study Population:

Patients with bladder tumour admitted under department of Urology for TURBT (Trans Urethral Resection of Bladder Tumour) surgery at Government Medical College Hospital, Thiruvananthapuram.

Inclusion criteria:

Patients with bladder tumour detected on history, clinical examination & imaging (Abdomino -pelvic Contrast Enhanced CT scan)

Exclusion criteria:

Patients with allergy to contrast material used in CT

Patients in renal failure

Sample Size:

All patients who underwent TURBT (Transurethral Resection of Bladder Tumour) surgery during the period from September 2019 to September 2021 were enrolled in the study.

There were 110 cases.

Data Collection Procedure:

After obtaining permission from Institutional Review Board, permission was taken from Superintendent of Medical College Hospital, Thiruvananthapuram, to retrieve case sheets of patients who underwent transurethral bladder tumour resection surgery in the specified time period. Permission was obtained from Institutional Ethics Committee thereafter. CT scan findings and histopathological examination reports were collected.

Study Variables:

Age

Gender

Presenting complaints

Prior history of bladder cancer

Clinical findings

Imaging findings and radiological (CT) stage of lesion

Transurethral cystoscopy findings and completeness tumour resection

Histopathological examination of specimen and pathological stage of lesion

Statistical Analysis:

The presentation of Categorical variables was done in the form of number and percentage (%). On the other hand, the quantitative data were presented as the means ± SD and as median with 25th and 75th percentiles (interquartile range). Sensitivity, specificity, positive predictive value and negative predictive value were calculated with respect to CT findings for muscle invasion after taking histopathology as gold standard. Inter-rater kappa agreement was used to assess strength of agreement between CT findings and histopathology. Univariate and multivariate logistic regression was used to find significant risk factors of muscle invasion.

The data entry was done in Microsoft EXCEL spreadsheet and the final analysis was done with the use of Statistical Package for Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, ver 25.0. For statistical significance, p value of less than 0.05 was considered statistically significant.

Ethical Considerations

Study was undertaken after obtaining clearance from the Institutional Ethics Committee

Names and initials of patients were not used for the study and due care was taken to preserve their anonymity.

There are no conflicts of interest

Funding agency: Nil

Results and Discussion

Table 1: Patient characteristics distribution.

Patient characteristics	Frequency	Percentage
Gender		
Female	50	45.45%
Male	60	54.55%
Prior history of bladder cancer		
No	8	7.27%
Yes	102	92.73%
Presenting complaints		
Haematuria	74	67.27%
Lower urinary tract symptoms	16	14.55%
Lower abdominal pain	12	10.91%
Asymptomatic	8	7.27%
Urine cytology		

Positive for malignant cells	83	75.45%
Negative for malignant cells	27	24.55%
Transurethral cystoscopy findings		
Visible tumour	87	79.09%
No visible tumour	23	20.91%
Abdomino-pelvic CT findings suggestive of muscle invasion		
Perivescical fat stranding	41	37.27%
Adjacent soft tissue nodularity	26	23.64%
Perivescical fat stranding and adjacent soft tissue nodularity	20	18.18%
No muscle invasion in CT	23	20.91%
Completeness of tumor resection		
Complete removal	83	75.45%
Incomplete removal	27	24.55%
Histopathology		
	60	54.55%
Muscle invasion absent	50	45.45%
Age(years)		
Mean ± SD	55.45 ± 10.6	
Median(25th-75th percentile)	54.5(46-64.75)	
Range	37-79	

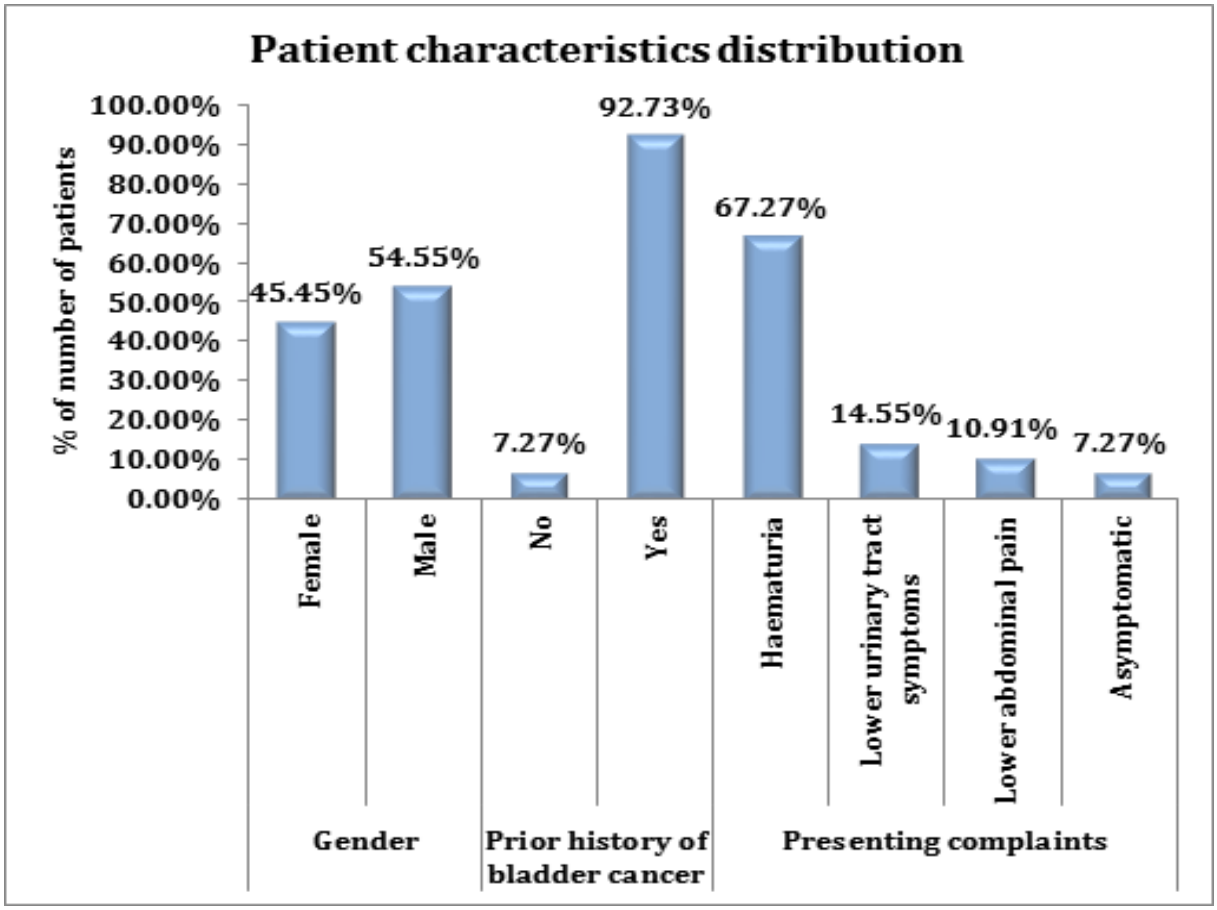

Figure 1.1: Patient characteristics distribution.

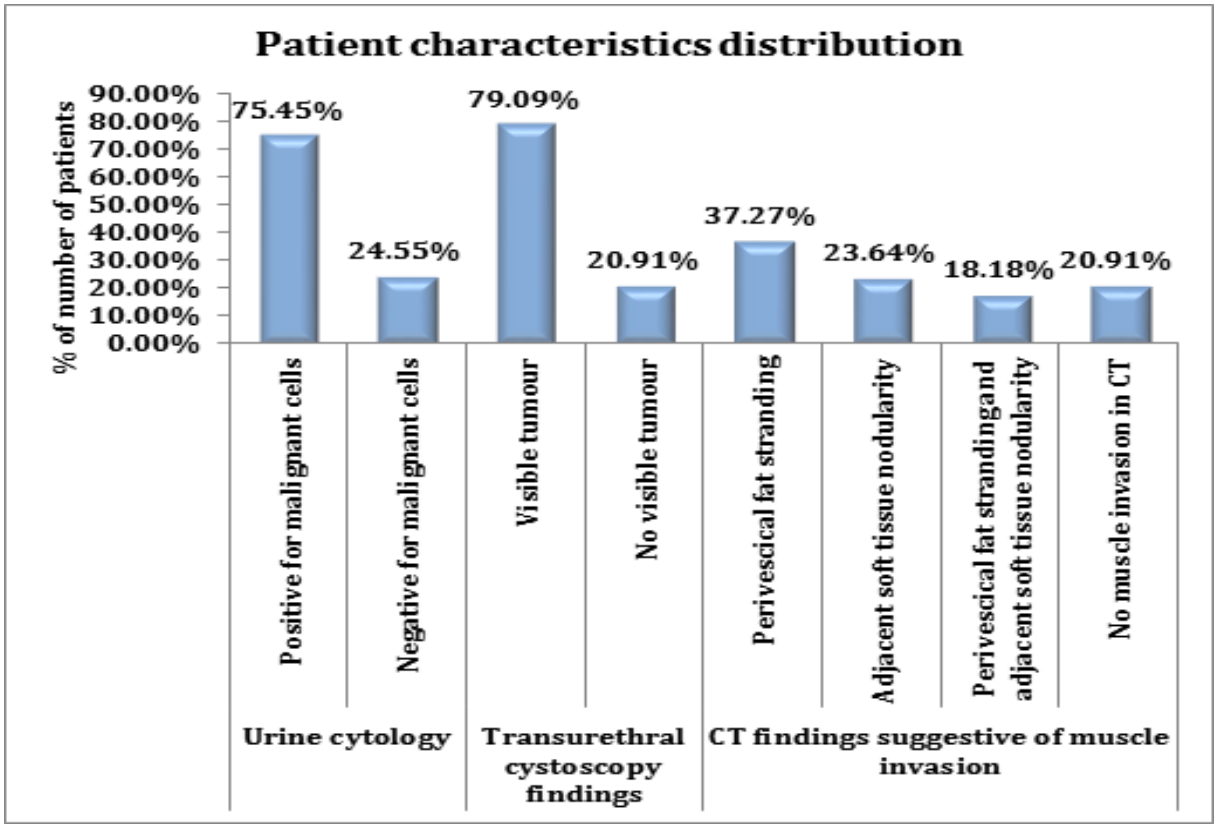

Figure 1.2: Patient characteristics distribution.

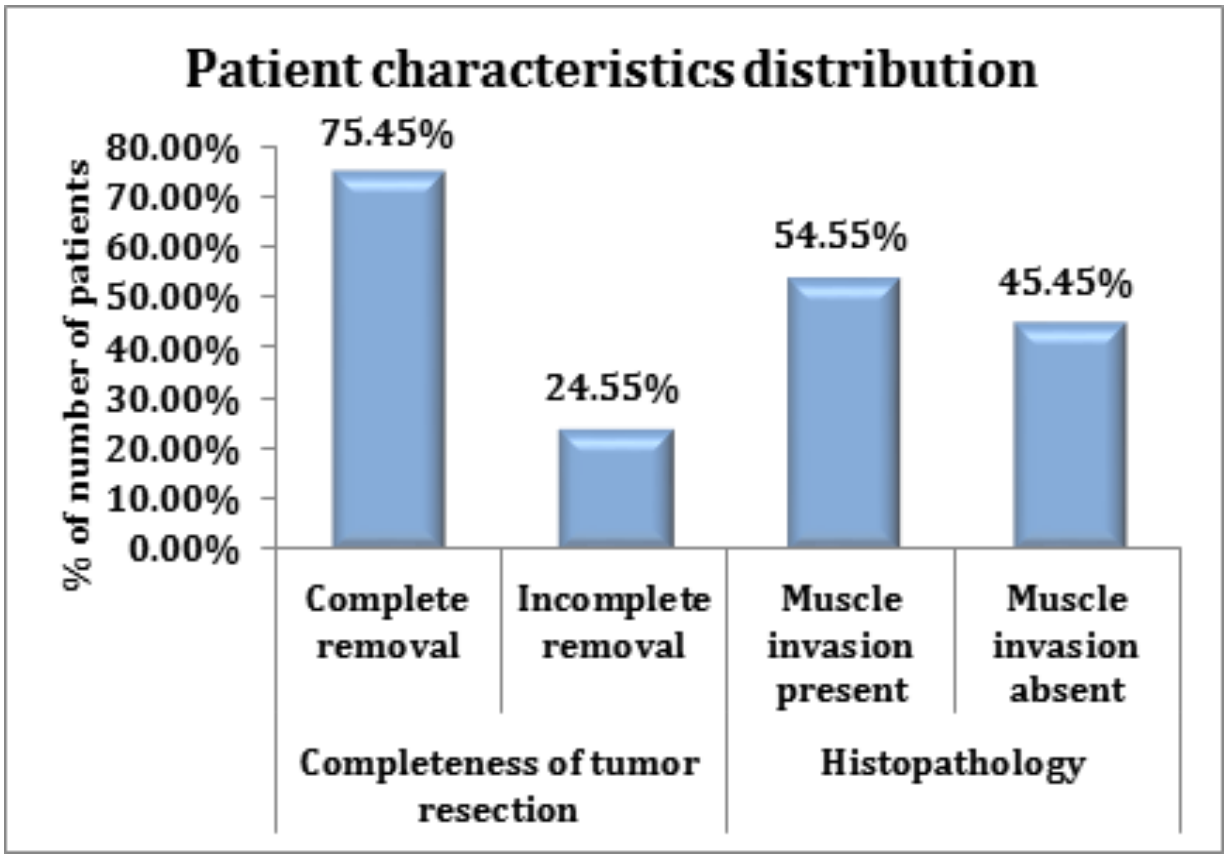

Figure 1.3: Patient characteristics distribution

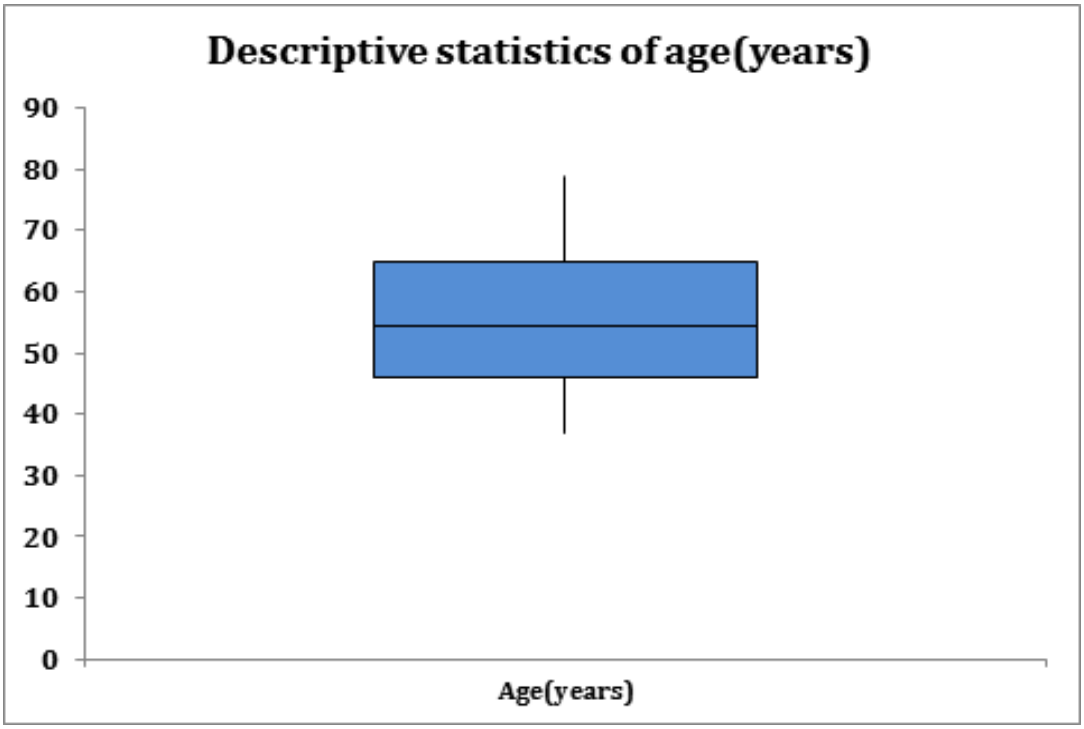

Figure 1.4: Descriptive statistics of age(years)

Mean value of age(years) of study subjects was 55.45 ± 10.6. 60(54.55%) patients were males and 50(45.45%) patients were females. Prior history of bladder cancer was present in 102(92.73%) cases.67.27% cases presented with haematuria, 14.55% presented with lower urinary tract symptoms,10.91% cases presented with lower abdominal pain and 7.27% cases were asymptomatic. 75.45% cases had positive cytology for malignant cells whereas 24.55% cases had negative cytology. 87(79.09%) cases had visible tumour on transurethral cystoscopy and 23(20.91%) cases had no visible tumour. 37.27% cases had perivescical fat stranding on abdomino-pelvic CT scan, 23.64% cases had adjacent soft tissue nodularity, 18.18% cases had both perivescical fat stranding and adjacent soft tissue nodularity and 20.91% cases had no muscle invasion in CT scan. According to histopathology,54.55% cases had muscle invasion. (Table 1, figure 1.1, 1.2, 1.3 and 1.4)

Table 2: Sensitivity, specificity, positive predictive value and negative predictive value of CT findings for muscle invasion after taking histopathology as gold standard.

Variables	Values
Sensitivity (95% CI)	88.33% (77.43% to 95.18%)
Specificity (95% CI)	32% (19.52% to 46.70%)
AUC (95% CI)	0.6(0.50 to 0.69)
Positive Predictive Value (95% CI)	60.92% (49.87% to 71.21%)
Negative Predictive Value (95% CI)	69.57% (47.08% to 86.79%)
Diagnostic accuracy	62.73%

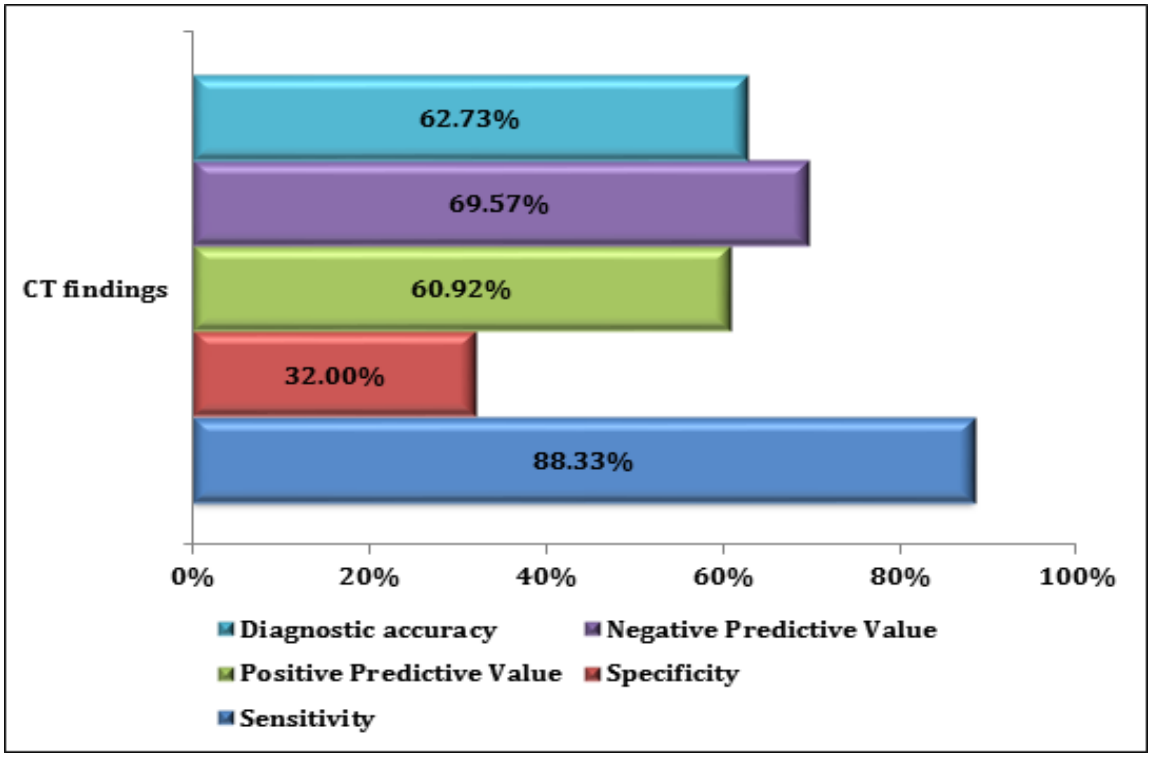

Figure 2: Sensitivity, specificity, positive predictive value and negative predictive value of CT findings for muscle invasion after taking histopathology as gold standard.

The above table shows that out of all the patients who had muscle invasion, 88.33% of patients had muscle invasion according to CT findings. If muscle invasion was present according to CT findings, then there was 60.92% probability of muscle invasion and if muscle invasion was absent according to CT findings, then there was 69.57% chances of no muscle invasion. Among patients who did not have muscle invasion in histopathology, 32% of patients did not have muscle invasion according to CT findings. (Table 2, figure 2)

Table 3: Inter-rater kappa agreement between CT findings and histopathology.

CT findings	Histopathology		Total	P value	Kappa
	Muscle invasion absent (n=50)	Muscle invasion present (n=60)			
Muscle invasion absent	16 (14.55%)	7 (6.36%)	23 (20.91%)	0.009	0.213
Muscle invasion present	34 (30.91%)	53 (48.18%)	87 (79.09%)		
Total	50 (45.45%)	60 (54.55%)	110 (100.00%)		

Fair agreement exists between histopathology and CT findings with kappa of 0.213 and p value of 0.009. Among 50 patients diagnosed as without muscle invasion via histopathology, 16 patients had similar findings in CT findings. Among 60 patients diagnosed as having muscle invasion via histopathology, 53 patients had similar findings in CT findings. Overall concordance rate was 62.73% and overall discordance rate was 37.27% between histopathology and CT findings. (Table 3)

Table 4: Univariate logistic regression to find significant risk factors of muscle invasion.

Variable	Beta coefficient	Standard error	P value	Odds ratio	Odds ratio Lower bound (95%)	Odds ratio Upper bound (95%)
Age(years)	-0.037	0.019	0.0495	0.964	0.929	1.000
Gender						
Female				1.000		
Male	-0.254	0.386	0.511	0.776	0.364	1.653
Prior history of bladder cancer	1.375	0.840	0.102	3.956	0.762	20.529
Presenting complaints						
Haematuria				1.000		
Lower urinary tract symptoms	-0.956	0.569	0.093	0.384	0.126	1.173
Lower abdominal pain	-1.129	0.657	0.086	0.323	0.089	1.172
Asymptomatic	0.047	0.766	0.951	1.049	0.234	4.702
Urine cytology						
Negative for malignant cells				1.000		
Positive for malignant cells	0.527	0.446	0.238	1.694	0.706	4.062
Transurethral cystoscopy findings						
No visible tumour				1.000		
Visible tumour	3.444	0.891	0.0001	31.315	5.458	179.678

On performing univariate regression, age and visible tumour in cystoscopy were significant risk factors of muscle invasion. With the increase in age(years), risk of muscle invasion significantly decreases with odds ratio of 0.964(0.929 to 1). Patients with visible tumour in cystoscopy had significantly high risk of muscle invasion with odds ratio of 31.315(5.458 to 179.678). (Table 4)

Table 5: Multivariate logistic regression to find significant risk factors for muscle invasion

Variable	Beta coefficient	Standard error	P value	Odds ratio	Odds ratio Lower bound (95%)	Odds ratio Upper bound (95%)
Age(years)	-0.042	0.022	0.052	0.959	0.919	1.000
Transurethral cystoscopy findings						
No visible tumour				1.000		
Visible tumour	3.481	0.896	0.0001	32.502	5.613	188.185

On performing multivariate regression, visible tumour in transurethral cystoscopy was found to be a significant independent risk factor of muscle invasion after adjusting for confounding factors. Patients with visible tumour in cystoscopy had a significantly higher risk of muscle invasion with adjusted odds ratio of 32.502(5.613 to 188.185). (Table 5)

In the majority of centres, CT urography remains the mainstay of urological investigation. This practice has been established as a result of a number of studies reporting the diagnostic benefits of

CT scanning. An early study by Caterino et al. [1] demonstrated a sensitivity and specificity of more than 90% in the diagnosis of bladder cancer. More recently, Turney et al. [2] demonstrated a sensitivity of 93% and specificity of 99% which supports earlier studies. The 64-slice multidetector CT scanner (MDCT) has significantly improved the detection rates of bladder carcinoma. Wang et al. [3] found that only one (pT1 lesion) of 44 histologically confirmed bladder tumours could not be detected. In addition, there was significant difference in the mean sizes of detectable (3.05 ± 1.79 cm) and nondetectable (0.65 ± 0.99 cm) tumours. Martingano et al. [4] reported that MDCT urogram had a sensitivity of 85% and specificity of 94%. It is supposed that better detection rates with 64 slices improves the quality of staging [5] At CT urography, urothelial carcinoma appears as an intraluminal papillary or nodular mass or focal wall thickening. Lesions may be missed without adequate bladder distention, especially small, flat tumors. CT demonstrates tumoral calcification in approximately 5% of cases [6]. The calcification typically encrusts the surface of the tumor and may be nodular or arched [7]. Bladder tumors enhance early, approximately 60 seconds from injection, and may be readily detected with multidetector CT. In one series of 20 patients, 100% of tumors were detected. With progression of disease, wall thickening may become diffuse. The presence of ureteral obstruction strongly suggests the presence of muscle invasion. Once the tumor has extended into the perivesical fat, increased attenuation or infiltration is noted in the perivesical fat.

Our study is one of the first studies in our region of the world which has looked at the ability of abdominopelvic CT scan to detect muscle invasion in bladder cancer as compared to histopathology which is the gold standard for the same. Histopathological examination is considered the gold standard modality to detect muscle invasion in bladder cancer.

The CT findings which are suggestive of muscle invasion include perivescical fat stranding, adjacent soft tissue nodularity or both. In our study there is 62.73% concordance rate between histopathology and CT findings with respect to muscle invasion with a good sensitivity of 88.33% for abdominopelvic CT scan to detect muscle invasion. In a study done my Kim et al [7],the positive predictive value for bladder cancer detection were 97% and 95%, respectively, in 67 patients and increased to 100% and 100%, respectively, in 44 patients with a time interval of 7 or more days between transurethral resection of the bladder(TURB) and CT examination. Sensitivity and specificity in the diagnosis of perivesical invasion were 89% and 95%, respectively, in 67 patients and increased to 92% and 98%, respectively, in 44 patients with a time interval of 7 or more days between TURB and CT examination. The sensitivity of abdominopelvic CT scan to detect muscle invasion is 88.37% in our study which is comparable to the above study.

Conclusion

To conclude, through this study we find that abdominopelvic CT scan has 88.37% sensitivity to detect muscle invasion as compared to the gold standard histopathology. Hence abdominopelvic CT scan can be utilised to reliably screen for muscle invasion in bladder carcinoma and also stage bladder carcinoma prior to resection and biopsy itself, although further studies using larger numbers of patients are required in future to substantiate the same.

Limitations

Although our study is one of the first of its kind to be done in our country to assess the diagnostic accuracy of abdominopelvic CT scan to detect muscle invasion in bladder cancer, the limitations of our study include relatively small sample size and retrospective nature of the study.

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