Original Article

Body composition between obstructive and non-obstructive bladder cancer: A retrospective study

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Abstract

Background: Body composition measurement during cancer follow-up would increase its role in improving the nutritional status. Using a CT scan for nutritional evaluation with scheduled cancer screening or follow-up would add other useful information to help the physician gain a better understanding of the patient's nutritional status, especially in adipose tissue.

Objective: To compare the measured adipose tissue and the skeletal muscle between obstructive and non-obstructive uropathy in bladder cancer on a CT scan.

Materials and Methods: A total of 69 patients, who underwent a CT scan of the abdomen including the pelvis before surgery and/or chemotherapy between January 2013 and December 2022, were enrolled. Analyses of the volume of visceral adipose tissue (VAT), subcutaneous adipose tissue (SAT), and skeletal muscle tissue (SMT) calculated based on CT images were performed.

Results: There was significantly lower VAT ($p = 0.012$) in the obstructive group than in the non-obstructive group. SAT, SMT, age, weight, height, BMI, and tumor size were not significantly different between both groups.

Conclusion: In patients with bladder cancer, those with obstructive uropathy showed lower VAT than non-obstructive uropathy.

Keywords: Bladder cancer, Body composition, Computed tomography, Skeletal muscle, Subcutaneous fat, Visceral fat.

Introduction

Urinary bladder cancer was the 10th most commonly diagnosed worldwide in 2020 and the 9th most common cancer in the Thai population (2.6%) [1]. The most common histology is urothelial carcinoma of the bladder, accounting for 90% of all urinary bladder cancers [2]. Cancer growth consumes massive energy. During progression, the patient usually loses appetite leading to anemia, poor immunity, weight loss, and cachexia. In a cachexic state, the patient would lose the body weight, the skeletal muscle, and the adipose tissue [3-4]. Cancer cachexia may half the quality of life, the mental health, the treatment response, and the survival [5].

Body mass index (BMI) is one of the fundamental indicators used to evaluate the nutritional status and cachexia, but only represents the total body composition and does not differentiate the ratio and alteration of fat and muscle mass. The muscle mass is significantly associated with the overall body condition and the nutritional status of cancer patients [6].

Body composition measurement during cancer follow-up would increase its role in improving the nutritional status. Because of the high price and the fact that it is rather time-consuming, some devices, such as Densitometry, MRI, TOBEC (total body electrical conductivity), and TBK (whole body potassium scanning), are hard to make a practical workflow in the situation of abundant patients on the same day [7].

Computed tomography (CT) is used for high-risk cancer patients or even an ongoing treatment to prove clinical suspicion and follow-up cancer progression or treatment response. It could show the whole body in the same period, vividly faster than the body composition measurement device. Using a CT scan for nutritional evaluation with scheduled cancer screening or follow-up would add other useful information to help the physician gain a better understanding of the patient's nutritional status, especially in adipose tissue [8-10].

The objective of this study was to compare the measured adipose tissue and skeletal muscle between obstructive and non-obstructive uropathy in bladder cancer on a CT scan.

Materials and methods

Ethical consideration

A retrospective descriptive diagnostic study was conducted at a university-based tertiary referral center in Thailand. The study was conducted following the Declaration of Helsinki, and the protocol was approved by the Ethics Committee for Human Research.

Study population

The medical records and CT scans of the abdomen including the pelvis of urinary bladder cancer patients from January 2013 to December 2022 were retrospectively reviewed. If patients underwent multiple studies of CT scan, the latest study prior to treatment was selected.

Inclusion criteria

1. Patients who were diagnosed with pathology-confirmed urinary bladder cancer
2. Patients who underwent CT scans of the abdomen including the pelvis

Exclusion criteria

1. Patients who underwent a surgery and/or a chemotherapy before undergoing the CT scan
2. Patients who had a previous history of some other type of cancer or concomitant diagnosed cancer at the examined date

Hardware and data acquisition

All images were performed by SOMATOM Definition Flash (SIEMEN®) with and/or without intravenous contrast before the surgery. The protocol of CT whole abdomen (pre-contrast phase, arterial phase, and portovenous phase) or CT urography (pre-contrast phase, nephrographic phase, and excretory phase) were used. The slice thickness and interval ranged from 3 to 10 mm with a median of 5 mm.

3D Slicer 5.2.2 (www.slicer.org, The Slicer Community) was used to measure using a semiautomatic segmentation method. The images were separated into three main components: visceral adipose tissue (VAT), subcutaneous adipose tissue (SAT), and skeletal muscle tissue (SMT) [8].

Image interpretation

The definition of obstructive uropathy was defined as at least 3 mm of ureter diameter or unilateral or bilateral dilated ureter [11].

The CT attenuation value of adipose tissue was defined as -100 to -50 Hounsfield units (HUs). Three-dimensional (3D) volumes at the level of the costophrenic angle to the iliac crest and two-dimensional (2D) cross-section areas at the level of the third lumbar spine (L3) mid-vertebra were measured for VAT, SAT, and SMT [12-15].

Statistical analysis

Statistical analyses were performed using IBM SPSS v28.0.0.0 (IBM Corp., Armonk, NY, USA). The descriptive analysis was used for demographic data (such as gender, age, weight, height, etc.). Differences between obstructive and non-obstructive uropathy were performed using independent T-test or chi-square test (or Fisher's exact test as appropriate). A p-value < 0.05 was considered statistically significant.

Results

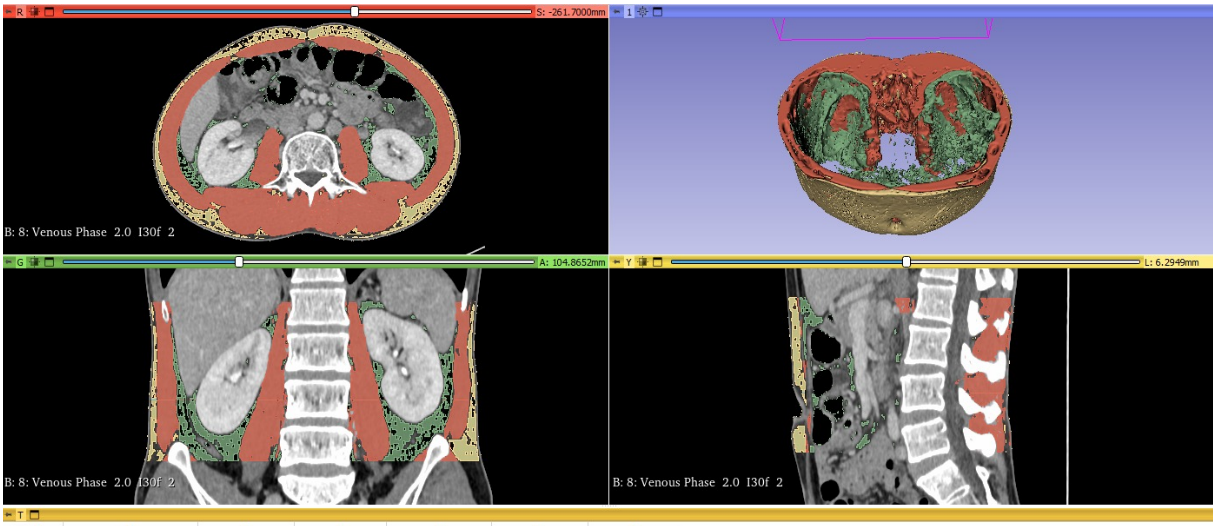
Out of 136 patients, 67 were excluded (27 for non-bladder cancers, 16 with concomitant cancers, and 24 without a pre-treatment study). Only 69 patients were eligible for enrollment. There were 57 patients with obstructive uropathy and 12 patients with non-obstructive uropathy.

Most patients were male with 48 (84%) in the obstructive group and 11 (92%) in the non-obstructive group. The mean age, height, BMI, and tumor size were not different between groups. More than half of the patients in both groups were in clinical stage III (Table 1).

Table 1. *Patients' demographic data.*

Parameters	Obstructive	Non-obstructive	p-value
Patients (Male : Female)	57 (48: 9)	12 (11: 1)	-
Age (Years)	65.4 + 9.9	70.5 + 9.0	0.590
Weight (kg)	60.5 + 10.6	60.8 + 10.7	0.737
Height (cm)	163.3 + 7.6	164.3 + 7.8	0.798
BMI (kg/m^2)	22.7 + 3.9	22.4 + 3.1	0.522
Tumor size (cm^3)	34.4 + 84.0	38.5 + 87.6	0.770
Clinical stage I	0 (0%)	0 (0%)	N/A
Clinical stage II	1 (1.7%)	3 (25%)	0.015
Clinical stage III	37 (64.9%)	7 (58.3%)	0.746
Clinical stage IV	19 (33.3%)	2 (16.7%)	0.321

A body composition analysis was performed using a semiautomatic segmentation, 3-dimensional (3D) volume at the level of the costophrenic angle to the iliac crest, and 2-dimensional (2D) cross-section areas at the level of 3rd lumbar spine (L3) (Figure 1).



	A	B	C	D	E	F	G
1	**Segment**	**Number of voxels [voxels]**	**Volume [mm3] (1)**	**Volume [cm3] (1)**	**Surface area [mm2]**	**Volume [mm3] (2)**	**Volume [cm3] (2)**
2	VAT	1696603	590275	590.275	440272	570077	570.077
3	SAT	991712	345032	345.032	238693	345026	345.026
4	VAT (L3)	4753	1653.64	1.65364	1962.52	461.614	0.461614
5	SAT (L)	8739	3040.43	3.04043	4442.85	1220.97	1.22097
6	SMT	3901949	1.35755e+06	1357.55	278507	1.36342e+06	1363.42
7	SMT (L3)	34075	11855.2	11.8552	23016.7	10805.1	10.8051

Figure 1. *Example of abdominal computed tomography for body composition analysis (upper left: axial plane, lower left: coronal plane, lower right: sagittal plane, upper right: 3D model, bottom: measured variables in 3D and 2D at the level of L3). Visceral adipose tissue (green), subcutaneous adipose tissue (yellow), and skeletal muscle tissue (red) were segmented.*

The mean VAT volume in the obstructive group was 851.9 cm^3, which is significantly lower than the non-obstructive group (mean = 1137.9 cm^3, $p = 0.012$). Other variables showed no statistically significant difference between groups (Table 2).

Table 2. *Significant difference analysis between obstructive and non-obstructive uropathy.*

Parameters	Obstructive (Mean + SD)	Non-obstructive (Mean + SD)	p-value
BMI (kg/m^2)	22.7 + 3.9	22.4 + 3.1	0.522
VAT (cm^3)	851.9 + 579.8	1137.9 + 579.8	0.012*
SAT (cm^3)	758.9 + 459.7	756.3 + 395.5	0.884
VAT-L3 (cm^2)	76.7 + 67.4	86.3 + 99.9	0.266
SAT-L3 (cm^2)	66.2 + 122.5	59.8 + 67.0	0.811
SMT (cm^3)	1493.2 + 419.2	1542.4 + 419.2	0.461
SMT-L3 (cm^2)	213.2 + 59.2	215.7 + 65.9	0.454
Tumor volume (cm^3)	34.4 + 84.0	38.5 + 87.6	0.770

**Statistical significance*

Discussion

There was no report of a correlation between obstructive and non-obstructive uropathy in bladder cancer that was measured by computed tomography [12-15]. There was one systematic review that collected related bladder cancer [9]. Previous studies were focused on a prognosis and the clinical outcome between pre-treatment and post-treatment with a multi-treatment plan by skeletal muscle index [16-19]. There was no study focusing on the correlation between variables in pre-treatment patients.

From the result, the VAT showed a statistic significance between obstructive and non-obstructive uropathy but not in the SAT which showed a similar result to previous studies [8]. Also, it was compatible with the previous meta-analysis studies or hypothesis that VAT was more vulnerable to prognosis than SAT or even BMI [9]. The obstructive group presented with lower VAT which was compatible with clinical prognosis revealing that obstructive uropathy tended to have a worse clinical outcome compared to the non-obstructive group. Lastly, the VAT showed more sensitive differences in patients' nutritional status than BMI [8, 12-15].

Obstructive uropathy was an obstruction of the urinary tract that could be caused by either structural or functional problem. The obstruction could present with typical combination of micturition, acute urinary retention, or lower abdominal discomfort and distension [20]. Untreated obstructive uropathy would eventually lead to chronic kidney damage or a disease that could reduce muscle mass via spontaneous reduction of albumin absorption [21].

The living quality of the patients with obstructive uropathy would be a vicious cycle as dysuria leads to nocturia, causes inadequate sleep, deterioration, and fatigue that causes dysuria again which is a cause of an excessive power expenditure over nights [22]. Combined with malnutrition, the insufficient energy to maintain daily activity forces the body to use the reserved tissue to survive [23].

Adipose tissue is a primary source of nutrition with a rapid process of lipolysis for turning the fat into glycerol for gluconeogenesis and ketone bodies as a direct fuel source for many tissues, including the brain. Also, it is the first in the three phases of response to the deprivation of nutrition. When fat depots are depleted, the skeletal muscle will be degraded by proteolysis to support the gluconeogenesis in the liver. In this situation, the body mass will rapidly decrease that can be shown in the reduction of BMI [24-25].

Further studies should be conducted with multiple hospitals to enroll sufficient patients to make the data solid. A comparison between groups of obstructive and non-obstructive uropathy with localized and metastatic cancers could potentially specify the prognosis that could create adequate data for clinicians to better understand patients' status and treatment planning, not only in the disease control but also in the overall quality of life.

Several limitations need to be considered when interpreting the results. The retrospective nature of the small sample size in the single-center study might lead to a selection bias and lower the confidence of the result. Non-structural records in the hospital digital clinical data and partially paper-based clinicians might contribute lower than the actual number of patients.

Conclusion

To our knowledge, this is the first study to have evaluated the difference in body composition of patients with urinary bladder cancer affected by obstructive uropathy. Obstructive uropathy showed lower VAT than non-obstructive uropathy.

References

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2021;71:209–49. doi: 10.3322/caac.21660.

2. Antoni S, Ferlay J, Soerjomataram I, Znaor A, Jemal A, Bray F. Bladder cancer incidence and mortality: A global overview and recent trends. Eur Urol 2017;71:96–108. doi: 10.1016/j.eururo.2016.06.010.

3. Baracos VE, Martin L, Korc M, Guttridge DC, Fearon KCH. Cancer-associated cachexia. Nat Rev Dis Primers 2018;4:17105. doi: 10.1038/nrdp.2017.105.

4. Grimberg DC, Shah A, Molinger J, Whittle J, Gupta RT, Wischmeyer PE, et al. Assessments of frailty in bladder cancer. Urol Oncol 2020;38:698–705. doi: 10.1016/j.urolonc.2020.04.036.

5. Fukushima H, Takemura K, Suzuki H, Koga F. Impact of sarcopenia as a prognostic biomarker of bladder cancer. Int J Mol Sci 2018;19:2999. doi: 10.3390/ijms19102999.

6. Tanaka K, Taoda A, Kashiwagi H. The associations between nutritional status, physical function and skeletal muscle mass of geriatric patients with colorectal cancer. Clin Nutr ESPEN 2021;41:318–24. doi: 10.1016/j.clnesp.2020.11.009.

7. Wells JC, Fewtrell MS. Measuring body composition. Arch Dis Child 2005;91: 612–7. doi: 10.1136/adc.2005.085522.

8. Tan CC, Sheng TW, Chang YH, Wang LJ, Chuang CK, Wu CT, et al. Utilizing computed tomography to analyze the morphomic change between patients with localized and metastatic renal cell carcinoma: body composition varies according to cancerstage. J Clin Med 2022;11:4444. doi: 10.3390/jcm11154444.

9. Sanchez A, Kissel S, Coletta A, Scott J, Furberg H. Impact of body size and body composition on bladder cancer outcomes: Risk stratification and opportunity for novel interventions. Urol Oncol 2020 ;38:713–8. doi: 10.1016/j.urolonc.2020.03.017.

10. Borga M, West J, Bell JD, Harvey NC, Romu T, Heymsfield SB, et al. Advanced body composition assessment: from body mass index to body composition profiling. J Invest Med 2018;66:1–9. doi: 10.1136/jim-2018-000722.

11. Potenta SE, D'Agostino R, Sternberg KM, Tatsumi K, Perusse K. CT urography for evaluation of the ureter. Radiographics 2015;35:709–26. doi: 10.1148/rg.2015140209.

12. Zhao L, Tian X, Duan X, Ye Y, Sun M, Huang J. Association of body mass index with bladder cancer risk: a dose-response meta-analysis of prospective cohort studies. Oncotarget 2017;8:33990–4000. doi: 10.18632/oncotarget.16722.

13. Rigiroli F, Zhang D, Molinger J, Wang Y, Chang A, Wischmeyer PE, et al. Automated versus manual analysis of body composition measures on computed tomography in patients with bladder cancer. Eur J Radiol 2022; 154:110413. doi: 10.1016/j.ejrad.2022.110413.

14. Franco-Villoria M, Wright CM, McColl JH, Sherriff A, Pearce MS; Gateshead Millennium Study core team. Assessment of adult body composition using bioelectrical impedance: comparison of researcher calculated to machine outputted values. BMJ Open 2016;6:e008922. doi: 10.1136/bmjopen-2015-008922.

15. Ying T, Borrelli P, Edenbrandt L, Enqvist O, Kaboteh R, Trägårdh E, et al. Automated artificial intelligence-based analysis of skeletal muscle volume predicts overall survival after cystectomy for urinary bladder cancer. Eur Radiol Exp 2021;5:50. doi: 10.1186/s41747-021-00248-8.

16. Miyake M, Morizawa Y, Hori S, Marugami N, Shimada K, Gotoh D, et al. Clinical impact of postoperative loss in psoas major muscle and nutrition index after radical cystectomy for patients with urothelial carcinoma of the bladder. BMC Cancer 2017;17237. doi: 10.1186/s12885-017-3231-7

17. Miyake M, Owari T, Iwamoto T, Morizawa Y, Hori S, Marugami N, et al. Clinical utility of bioelectrical impedance analysis in patients with locoregional muscle invasive or metastatic urothelial carcinoma: a subanalysis of changes in body composition during neoadjuvant systemic chemotherapy. Support Care Cancer 2018;26:1077–86. doi: 10.1007/s00520-017-3924-0.

18. Phuong A, Marquardt JP, O'Malley R, Holt SK, Laidlaw G, Eagle Z, et al. Changes in skeletal muscle and adipose tissue during cytotoxic chemotherapy for testicular germ cell carcinoma and associations with adverse events. Urol Oncol 2022;40:456.e19-456.e30. doi: 10.1016/j.urolonc.2022.07.013.

19. Stangl-Kremser J, D'Andrea D, Vartolomei M, Abufaraj M, Goldner G, Baltzer P, et al. Prognostic value of nutritional indices and body composition parameters including sarcopenia in patients treated with radiotherapy for urothelial carcinoma of the bladder. Urol Oncol 2019;37:372–9. doi: 10.1016/j.urolonc.2018.11.001.

20. Rishor-Olney CR, Hinson MR. Obstructive uropathy. [Updated 2023 Jul 22]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan- [cited 2024 Jul 4]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK558921/

21. Jensen GL. Malnutrition and nutritional assessment. In: Loscalzo J, Fauci A, Kasper D, Hauser S, Longo D, Jameson J, editors. Harrison's principles of internal medicine [Internet]. 21th ed. McGraw Hill; 2022 [cited 2024 Jul 4]. Available from: https://accessmedicine.mhmedical.com/content.aspx?bookid=3095&sectionid=264532265

22. Ancoli-Israel S, Bliwise DL, Nørgaard JP. The effect of nocturia on sleep. Sleep Med Rev 2011;15:91–7. doi: 10.1016/j.smrv.2010.03.002.

23. Wensveen FM, Valentić S, Šestan M, Turk Wensveen TT, Polić B. Interactions between adipose tissue and the immune system in health and malnutrition. Semin Immunol2015;27:322–33. doi: 10.1016/j.smim.2015.10.006.

24. Lyon TD, Frank I, Takahashi N, Boorjian SA, Moynagh MR, Shah PH, et al. Sarcopenia and response to neoadjuvant chemotherapy for muscle-invasive bladder cancer. Clin Genitourin Cancer 2019;17:216-22.e5. doi: 10.1016/j.clgc.2019.03.007.

25. Wang Y, Chang A, Tan WP, Fantony JJ, Gopalakrishna A, Barton GJ, et al. Diet and exercise are not associated with skeletal muscle mass and sarcopenia in patients with bladder cancer. Eur Urol Oncol 2021;4:237–45. doi: 10.1016/j.euo.2019.04.012.