



Determining the Role of Immunohistochemical Expression of CK20 in Grading Urothelial Carcinoma

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: The cytoskeleton-associated intermediate filaments, CK20 belong to epithelial subgroups and it has a controlled expression in gastrointestinal marked cells and in the urinary tract. During embryogenesis, cytokeratin is the first intermediate filament type and they provide facilitation in maintaining the integrity and mechanical stability of cells. It is identified with regard to neoplastic urothelial cells there is a strong and diffuse cytoplasmic immunoreactivity for CK20 that involve all three layers of the urothelium. Therefore, the aim of the study was to determine the role of the immunohistochemical expression of CK20 in the grading of urothelial carcinoma.

Methodology: It was a retrospective cross-sectional study that was conducted at the Department of Histopathology, Lady Reading Hospital, Peshawar, Pathology department, Sheikh Zayed medical college and Hospital, Rahimyar Khan and Khyber Medical college and Khyber Teaching Hospital, Peshawar from March 2021 till September 2021. Ninety-seven, (97) Paraffin-embedded blocks of urothelial carcinoma along with records of these patients, which were collected over three

years from January 2018 till December 2020, were retrieved from the archives of the Histopathology departments of these hospitals. These blocks were cut and stained with Hematoxylin Eosin and CK20 antibodies. Expression of CK20 was noted by two consultant pathologists. Positive expression was considered when cytoplasmic immunohistochemistry expression of CK20 was seen in deep layers of the urothelium or diffused strong cytoplasmic staining of urothelial cells beyond the superficial cells was found. Negative expression was defined as CK 20 staining restricted to the superficial cells or Negative expression was defined as CK 20 staining restricted to superficial "Umbrella" cells of urothelium.

Results: Out of 97 patients, the minimum age was 20 years and maximum age was found to be 90 years with mean \pm standard deviation of 64 \pm 11 years. There were 86 (88.6%) male patients and 11 (11.3) female patients. Low grade urothelial carcinoma was seen in 49(51 %) patients while 48 (49%) cases displayed high grade morphology. CK20 was found positive in 74 (76.3%) patients. Among positive cases, 43 cases were high grade and 31 cases were low grade urothelial carcinomas.

Conclusion: CK20 Positivity was seen in 76.3% of the patients with papillary urothelial carcinoma. CK20 is an important immunohistochemical marker for early diagnosis and grading of urothelial carcinomas. Positive Immunohistochemistry staining of the urothelial carcinomas were found in high-grade as well as low-grade urothelial carcinomas but in comparison, 43 cases of high-grade urothelial carcinomas had exhibited positive immunohistochemistry staining for CK 20 and 31 cases of low-grade urothelial carcinomas had exhibited positive staining for CK20 which would indicate that perhaps immunohistochemistry staining features of urothelial carcinoma would tend not to completely differentiate between high-grade and low-grade urothelial carcinomas.

Keywords: CK20; urothelial carcinoma; immunohistochemical expression.

1. INTRODUCTION

Among the cancers of the urinary system, bladder cancer is the most common malignancy which had affected 549,393 individuals and had caused the death of 199,922 patients across the globe in 2018. Histologically, Urothelial carcinoma (UC) accounts for 90% of bladder malignancies among all the reported cases [1]. It is estimated that bladder carcinoma is the 9th most common cancer worldwide and the thirteenth most frequent cause of death among the patients with cancers associated to the urinary system [2]. In the United States, it is the fourth most common cancer in males and the tenth most common tumor in females with a male to female ratio of 3:1 and the median age of diagnosis is 68years [3]. In Pakistan, a study conducted in the Armed Forces Institute of Pathology Rawalpindi showed that bladder carcinoma is the 7th most common tumor in both males and females and represented 93.4% of all bladder cancers [2].

It has been identified that cigarette smoking has a strong association with bladder cancer [4]. Other predisposing factors include arylamines, aniline dyes, phenacetin, auramine and cyclophosphamide, Schistosoma haematobium, and prior radiation exposure of bladder for treatment of prostatic cancer [5]. WHO/ISUP in

its latest classification of tumors of the urinary tract classified urothelial tumors into infiltrating (muscle-invasive) and noninvasive urothelial neoplasms. Among the infiltrating Urothelial carcinomas, various subtypes like Nested-variant, Microcystic-variant, Micropapillary-variant, Plasmacytoid-variant, Sarcomatoid-variant, Giant cell-variant, Lymphoepithelioma like-variant Lipid rich-variant, Clear cell-variant and Poorly-differentiated variant, are included. The noninvasive urothelial neoplasms are subclassified into Urothelial carcinoma in situ, papilloma, papillary urothelial neoplasm of low-grade malignant potential (PUNLMP), Noninvasive papillary urothelial carcinoma, low grade (LGUC), and Noninvasive papillary urothelial carcinoma, high-grade (HGUC) [6]. Prognosis of urothelial carcinoma is determined by various factors like pathological grade and stage of tumor, and the age of the patient [7]. Among these, the Grade of the tumor is the single most important prognostic factor. The prognosis of LGU Cis generally good, though these tumors show high Recurrence rates. Approximately 30% of these recurrent tumors progress by invading lamina propria [8].

Among the cytoskeleton-associated intermediate filaments, CK20 belongs to epithelial subgroups and it has a controlled expression in gastrointestinal marked cells and in the urinary

tract. During embryogenesis, cytokeratin is the first intermediate filament type and they provide facilitation in maintaining the integrity and mechanical stability of cells. The urothelium of the bladder has multilayered epithelium with three different cell zones i.e. i. basal cells ii. intermediate cells zone and iii. superficial cell layer. In adults, urothelium CK20 expression is restricted to the superficial cell umbrella layer however, in neoplastic urothelial cells there is strong and diffuse cytoplasmic immunoreactivity for CK20 that involve all three layers of the urothelium [9]. The staining pattern of CK20 can be an adjunct in the early diagnosis of urothelial cancer and can envisage malignant potential in low grade urothelial tumors [10]. This study was designed to delineate the diagnostic utility of CK20 antibody in classifying urothelial carcinoma into high grade and low-grade forms based on the expression of CK20.

2. METHODOLOGY

A retrospective cross-sectional study was conducted at the department of Histopathology, Lady Reading Hospital, Peshawar in collaboration with Pathology department, Sheikh Zayed medical college & Hospital, Rahim Yar Khan and Khyber Medical college & teaching Hospital, Peshawar from March till September 2021. The sample size was calculated using WHO sample size calculator according to following parameters; Confidence level (1-a=95 %); Anticipated population proportion (P) = 49.5%; Absolute precision required (d) = 10 %; Minimum sample size (n) = 97. Formalin fixed, Paraffin embedded 97 blocks of already diagnosed cases of urothelial carcinoma were included in the study using non probability, consecutive sampling technique. Poorly preserved, autolyzed and inadequate bladder biopsies were excluded from the study. Data collection proforma of the patients was filled with record retrieved from histopathology data bank of these institutions. Retrieved blocks were cut at 3-5um thick sections for routine Hematoxylin and Eosin staining. Immunohistochemical assay for CK20 were done by using DAKO kit according to manufacturer's guidelines as follow: The blocks were sectioned at 3 um thickness and placed on clean glass slide with pre- attached adhesive on its surface. They were incubated at 58 degrees Celsius for 4 hours. The sections were deparaffinized with xylene 1 and 2, for 3 minutes each. They were rehydrated in decreasing concentrations of alcohol, 90% 80% and 70% for 3 minutes each.

The slides were placed in coplin jar with 0.01 M Tris-EDTA buffer at pH of 9.0. 750W domestic microwave was used to treat the slides for 20-30 minutes for heat mediated antigen retrieval. Slides were washed with distilled water for 20-40 minutes. After cooling down the sections, they were brought to phosphate buffered saline (PBS) at pH 7.3 for 5 minutes. PBS was washed and excess was wiped off the sections. Endogenous peroxides activity was blocked by incubation in 0.5% hydrogen peroxide in methanol for 5 minutes. The slides were washed in three series of PBS, 2 minutes each. 100 microliters of primary antibody of CK20 were instilled on the sections and incubated for 60 minutes. The slides were again washed in three series of PBS, for 60 minutes. The slides were then incubated in avidin-biotin complex for 10 minutes. They were rinsed with distilled water and then incubated in DAP (diaminobenzidine) substrate solution for 5 minutes. Then the slides were washed with water and counter stained with hematoxylin for 40 seconds. The slides were dehydrated by placing them in increasing concentrations of alcohol 70%,80%,90% and 100% alcohol for 3 minutes each. Clearing was done by placing slides in xylene for 3 minutes. The slides were mounted with Canada balsam. Non neoplastic urinary bladder tissue was used as negative control while formalin fixed paraffin embedded block of skin tissue was used as positive control. Slides were examined by two consultant histopathologists, blind to the original issued reports. Histopathologic diagnoses were made for all the cases included in study and recorded in a predesigned proforma. Then CK20 antibody-stained slides were examined and each case was assigned positive or negative status based on the nuclear staining intensity and percentage score. Strong nuclear immunoreactivity in more than 10% of tumor cells was considered positive. Negative status was recorded for a case with either no staining or staining in less than 10% of tumor cells. Gender, age, CK20 immunohistochemical expression and grade of tumor were recorded. SPSS version 26 was employed for statistical analysis. Calculation of mean and Standard Deviation was done for numerical variables like age. Gender, age, tumor grade and immunohistochemical expression of CK20 were expressed in frequencies and percentages. Through stratification, effect modifiers including age, tumor grade and gender were controlled. T-test was applied by taking p-value of less than 0.05 as significant.

3. RESULTS

Among 97 cases, the minimum and maximum age of patient recorded was 20 years and 90 years with a mean+ standard deviation as 41.18 + 12.66 years. There were 86 (88.6%) male patients and 11 (11.3%) patients were females making male to female ratio of 7.8:1. 42 males had HGUC while 44 male patients were diagnosed with LGUC. Among the 11 female patients, 06 cases showed high grade morphology while 05 cases were classified as LGUC. Papillary urothelial carcinoma, low grade (LGUC) was seen in 49 (50.5%) patients while sections from 48 (49.5%) of the cases showed papillary urothelial carcinoma, high grade (HGUC) as shown in Fig. 1. Immunohistochemically, CK20 was found positive in 78 (80.4%) patients and it was negative in 19 (19.6%) patients. Among the positive cases, 46 were HGUC and 32 were LGUC. Out of 19 negative cases, 02 cases showed high grade morphology while 17 cases showed features of LGUC as shown in Table 1. Among the CK20 positive cases, 29 cases showed muscle invasion while muscle invasion was seen in 03 cases which did not show any CK20 expression making a highly significant correlation between muscle invasion and CK20 expression (p-value <0.001) as shown in Table 2. Expression of CK20 was

seen in 68 male patients and 10 female patients while no expression was seen in 18 male patients and 1 female patient (p value< 0.001) as shown in Table 3.

4. DISCUSSION

With advancement in diagnostic methods over the last two decades, it is now common to use immunohistochemical markers for assessing predictive and prognostic potential of various tumors in this regard multiple immunohistochemical biomarkers have been explored in cases of urothelial carcinoma of urinary bladder [11]. In our current study, we assessed the role of CK20 in the grading of urothelial carcinoma. In the present study the role of CK20 in the grading of urothelial carcinoma CK20 which belongs to a family of intermediate filaments, was assessed. A total of 97 patients were included in our study in which the calculated mean age of the patients was 64+11 years. There were 86 (88.6%) male patients and 11(11.3%) female patients, making the male to female ratio 7.8:1. Opposite to our findings, the male to female ratio of 4:1 was published by a group who included the same number of patients in their research; (5) however in another study investigators found a male to female ratio of 7.46:1 which is concordant with our results [12].

Table 1. Co-relation of CK20 expression with tumor grade

Tumor Grade	CK20 Expression				p-value
	Negative	Frequency (%)	Positive	Frequency (%)	
High Grade	02	02	46	47	P<0.001*
Low Grade	17	18	32	33	
Total	19	19.6	78	80.4	

*p-value is significant at <0.05 level

Table 2. Co-relation of CK20 expression and muscle invasion

CK20 expression	Muscle Invasion		p-value
	Present	Absent	
Negative	3	16	p<0.001*
Positive	29	49	
Total	32	65	

*p-value is significant at <0.05 level

Table 3. Co-relation of CK20 expression and patients' gender

Gender	CK20 Expression		p-value
	Negative	Positive	
Male	18	68	p<0.001*
Female	1	10	
Total	19	78	

*p-value is significant at <0.05 level

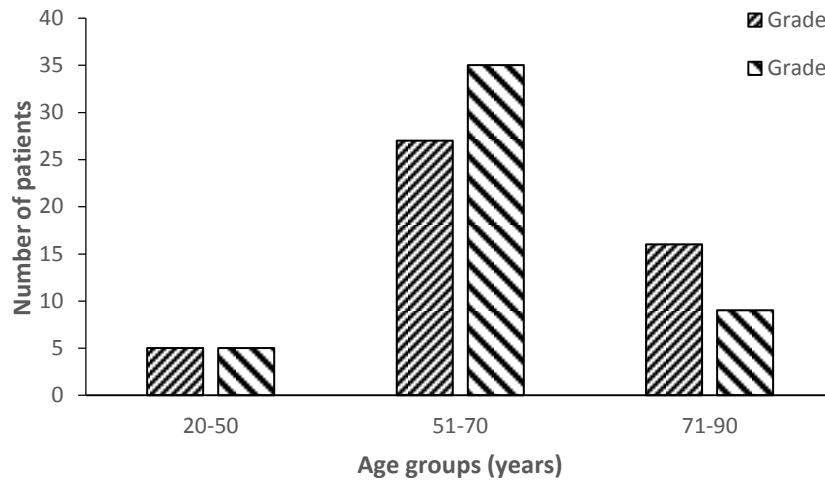


Fig. 1. Co-relation of patients' age group with tumor grade

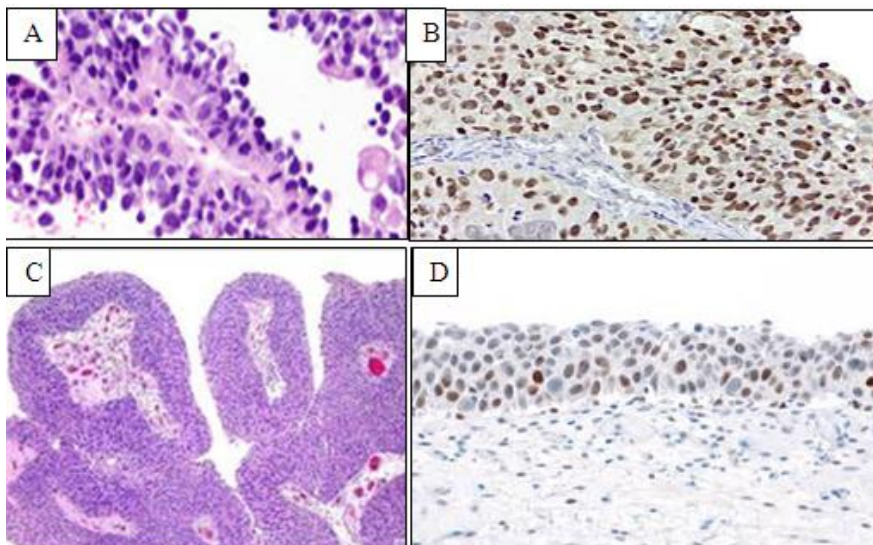


Fig. 2. Noninvasive papillary urothelial carcinoma. High grade urothelial carcinoma H&E (A), Strong CK20 (B); Low-grade urothelial carcinoma H&E (C), Weak CK20 (D)

We did not find any significant association between the age group and grading of urothelial carcinoma. A study was conducted in Turkey over 18 years to see the potential effect of age on the natural behavior and progression of bladder cancer in different age groups. They found that single and small tumors were usually present in patients younger than 40 years with lower recurrence rate but similar tumor progression rate in both young and old age groups. They concluded their manuscript with remarks that invasiveness of tumors in young patient must be assessed carefully, and intervention should be initiated earlier to halt the progression for better outcome [13].

In the present project, 78 (80.4%) of the cases yielded positive results while 19 (19.6%) cases showed negative results for CK20 over expression on application of CK20 antibody. Among CK20 positive cases, 46 cases were HGUC and 02 cases were LGUC. Among the negative 19 cases, 17 cases were LGUC while 32 cases showed high grade morphology on hematoxylin and Eosin-stained sections. CK20 was positive in 74 (76.3%) patients with 43 high grade and 31 low grades. It was negative in 23 (23.7%) patients with 5 high grade and 18 low grade carcinomas. A study had concluded that CK20 in 33 cases (68.8%) is useful marker in the grading of urothelial cancer where features are

borderline [5]. Mumtaz et al found diffuse positive expression of high grade and 16 (40%) of low grade tumor. CK 20 expression for grading of urothelial carcinoma has been studied widely done and with other immunohistochemical biomarkers [5]. Yin H et al, studied three immunohistochemical markers p53, CK20 and Ki67 on 84 urothelial tumors using WHO/ISOP classification for grading. They found 64% low grade and all high-grade carcinomas show diffuse staining of CK20 while remaining [13] 36% low grade carcinoma show focal staining. These findings are in accordance with our study.

Double staining of cytokeratin is a helpful tool to identify the behavior and nature of urothelial carcinoma. It has been stated that CK20 expression has the potential to predict the malignant changes in low grade urothelial carcinoma and the diffused CK20 staining along with loss of CK5/6 has been associated with aggressive behavior of carcinoma [9]. In another study it has been suggested by sheikh et al that CK20 expression has a role in the assessment of recurrence of low-grade urothelial carcinoma. It has been stated that the tumors that exhibit chromal CK20 expression are more likely to reoccur [14].

The objective of our current study was to assess the relationship of immunoreactivity of CK20 across the spectrum of urothelial neoplasia using WHO/ISUP classification. The study concluded that increased CK20 positivity was significantly associated with increased tumor grade and stage [15].

Urothelial carcinoma in situ in bladder can be difficult to diagnose due to factors including procedures artifacts, therapy related changes and different growth patterns. In difficult cases CK 20 was found to be more sensitive, and this was consistent strong staining as compared to alpha-methylacyl-CoA racemase (AMACR) [16]. In another study Gata3, CK 20, CK5/6 and CK14 immunohistochemical markers were used for the subtyping of bladder cancer. Positive expression of CK20, was found in 50.8% of patients that had muscle invasive bladder cancer. GATA3, CK20, CK5/6, CKU staining were used to predict clinical outcome and survival after radical cystectomy. CK20 immunopositivity expression was noted in luminal molecular subtype [17].

According to this study, urothelial carcinomas are divided into two immunocytochemical subtype.

Basal subtype which are CK5 positive, CK20 negative or CK5 positive and GATA3 negative). The luminal subtype is (CK5 negative and CK20 positive) In this study CK20 expression was used in molecular subtyping of urothelial carcinoma [18]. In this study, CK20 and CK5/6 IHC panel was used to classify the urothelial carcinoma into 3 groups, it was noted that high expression at CK20 in group 3 was associated with worse progress. According to molecular study there was identified cell adhesion and increased proliferation in group 3. Therefore, CK20 can be used as easily accessible prognostic marker in daily practice. As its high expression is associated with worse prognosis [19].

Urinary bladder flat lesion carcinoma in situ is a worrisome lesion, which requires aggressive surveillance and treatment, CK20 is the most widely used immunohistochemical marker for discrimination of urothelial carcinoma in situ (cis) from reign or reactive urothelium. CK20 was positive in 20 specimens (29%), 11 (16%) showed patchy equivocal staining, 38 (55%) had negative staining [20]. In another descriptive study, urinary bladder samples were collected from 50 patients in Iran. According to that study CK20 positivity was 84.6%. They concluded CK20 as specific marker for diagnosis of low and high grade pupillary urothelial carcinoma [21].

5. CONCLUSION

CK20 Positivity was seen in 76.3% of the patients with papillary urothelial carcinoma. CK20 is an important immunohistochemical marker for early diagnosis and grading of urothelial carcinomas. Positive Immunohistochemistry staining of the urothelial carcinomas were found in high-grade as well as low-grade urothelial carcinomas but in comparison, 43 cases of high-grade urothelial carcinomas had exhibited positive immunohistochemistry staining for CK 20 and 31 cases of low-grade urothelial carcinomas had exhibited positive staining for CK20 which would indicate that perhaps immunohistochemistry staining features of urothelial carcinoma would tend not to completely differentiate between high-grade and low-grade urothelial carcinomas.

CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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