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REVIEW
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Factors Associated with Survival From Xp11.2 Translocation Renal Cell Carcinoma Diagnosis—A Systematic Review and Pooled Analysis

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Purpose: Xp11.2 translocation renal cell carcinoma (Xp11.2 tRCC) is a rare subtype of renal cell carcinoma (RCC), characterized by translocations of Xp11.2 breakpoints, involving of the transcription factor three gene (TFE3). The aim of our study was to comprehensively characterize the clinical characteristics and outcomes, and to identify risk factors associated with OS and PFS in Xp11.2 tRCC patients.

Methods: Literature search on Xp11.2 tRCC was performed using databases such as pubmed EMBASE and Web of Science. Studies were eligible if outcomes data (OS and/or PFS) were reported for patients with a histopathologically confirmed Xp11.2 tRCC. PFS and OS were evaluated using the univariable and multivariable Cox regression model.

Results: There were 80 eligible publications, contributing 415 patients. In multivariable analyses, the T stage at presentation was significantly associated with PFS (HR: 3.87; 95% CI: 1.70 to 8.84; $p = 0.001$). The median time of PFS was 72 months. In the multivariable analyses, age at diagnosis (HR: 2.16; 95% CI: 1.03 to 4.50; $p = 0.041$), T stage at presentation (HR: 4.44; 95% CI: 2.16 to 9.09; $p < 0.001$) and metastasis status at presentation (HR: 2.67; 95% CI: 1.12 to 6.41; $p = 0.027$) were all associated with OS, with a median follow-up time of 198 months.

Conclusion: T stage at presentation is the only factor that is associated with both PFS and OS in patients with Xp11.2 tRCC. Also, patients over 45 or with metastases are more likely to have poorer OS.

Keywords: TFE3, kidney, Xp112 translocation renal cell carcinoma, survival, prognosis

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INTRODUCTION

Since being listed as a new type of renal cell carcinoma (RCC) by the World Health Organization (WHO) in 2004 [1], Xp11.2 translocation renal cell carcinoma (Xp11.2 tRCC) has received wide attention around the world [2]. It's a rare subtype characterized by several different chromosomal translocations of Xp11.2 breakpoints and involves the formatting of the transcription factor three gene (TFE3), leading to a fusion gene with a significant overexpression of TFE3 protein in tumor cells

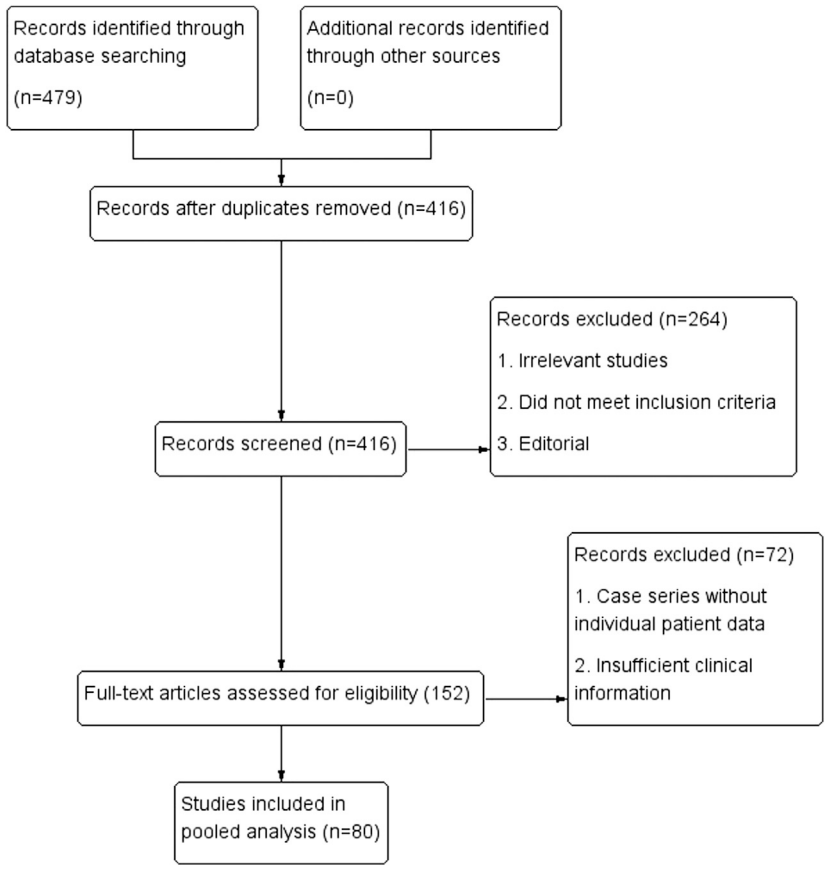

FIGURE 1 | Flow diagram showing the selection process for the systematic review.

[3]. It's reported that, compared with Xp11.2 tRCC, RCC associated with t (6; 11) (p21; q12)/TFEB gene fusions has similar epidemiology pathology, and genetics characteristics [4]. In 2016, WHO newly designated Xp11.2 tRCC as microphthalmia-associated transcription (MiT) family translocation RCC since both TFE3 and TFEB belong to MiT factor family [5].

Xp11.2 tRCC, which predominantly occurs in children and young adults, is more aggressive than other conventional RCC due to its advanced stages and invasive clinical courses in adults, regardless of its low incidence [6]. Microscopically, it is difficult for pathologists to distinguish Xp11.2 tRCC from other types of RCC. Although immunohistochemistry (IHC) can detect the overexpression of TFE3 protein that is involved in TFE3 gene, serving as the basic method for diagnosis of Xp11.2 tRCC, high false-positive rates and low predictive values were reported [7]. Thus, the fluorescent *in situ* hybridization (FISH) provides a way which is more accurate in identifying the TFE3 gene rearrangement with higher sensitivity [7].

However, the prognosis of Xp11.2 RCC is still controversial due to the low appearance of series with enough number of patients and the short follow-up period. Also, the rarity of this disease and its under-recognition lead to few articles on Xp11.2 tRCC progressing that have been published, most of which were performed in the form of single case report and small series, limiting the generation of definitive conclusions regarding clinical characteristics, risk factors, prognosis and treatment. Therefore, it is necessary to identify the OS and PFS, as well as the factors that are associated with prognosis in patients with Xp11.2 tRCC.

In this study, we have systematically reviewed the studies on Xp11.2 tRCC to comprehensively characterize the clinical characteristics and outcomes, and to identify risk factors associated with OS and PFS in Xp11.2 tRCC patients.

PATIENTS AND METHODS

Search Strategy

The following databases were searched by October 2020: PubMed, EMBASE, Web of Science and other specialty meeting abstracts. The search terms used are as follow: (TFE3 OR XP11.2 OR MITF translocation) AND (renal cell carcinoma OR RCC). There were no limitations on the language or published time of studies. Reference lists were also checked for relevant articles. The most recent publications were chosen when they included updates to prior ones.

Inclusion and Exclusion Criteria

Two reviewers (Wu and Liu) independently screened the identified abstracts for eligibility and full articles for detailed evaluation. Studies were eligible if outcomes data (OS and/or PFS)

TABLE 1 | Patient and Tumor Characteristics at Xp11.2 tRCC Diagnosis.

Characteristics	No. of patients	%
Age, years		
Median	33	
Range	1–86	
Sex		
Male	176	43.67
Female	227	56.33
Location		
Right	167	57.99
Left	121	42.01
Clinical manifestations		
Symptomatic	129	57.33
Asymptomatic	96	42.67
Disease history		
Yes	21	30.00
No	49	70.00
Stage		
1	123	38.80
2	36	11.36
3	77	24.29
4	81	25.55
pT		
1	192	53.04
2	57	15.75
3	99	27.35
4	14	3.86
pN		
0	185	64.91
1	63	22.11
2	37	12.98
pM		
0	281	82.16
1	61	17.84
Fuhrman		
1	1	0.77
2	39	30.00
3	67	51.54
4	23	17.69
Primary treatment		
Surgery	406	98.78
No surgery	5	1.22
Type of surgery		
Radical nephrectomy	276	77.97
Partial nephrectomy	78	22.03
Adjuvant treatment		
None	131	48.52
Targeted therapy	74	27.41
Immune therapy	56	20.74
Chemotherapy	9	3.33

were reported for patients with a histopathologically confirmed Xp11.2 tRCC, which was diagnosed by TFE3-IHC or FISH. When the result of TFE3-IHC was different from FISH, the result of FISH was taken to decide the final diagnosis.

Studies were excluded if they were 1) lack of available outcomes data; 2) with ambiguous inclusion criteria; 3) reviews; 4) not performed in human. When same group of patients were reported from one institution in different studies, the most recent data were chosen.

Data Extraction

Two authors (Wu and Zhang) independently extracted the following data from included articles if available: 1) first author; 2) year of publication; 3) age at Xp11.2 tRCC diagnosis; 4) patient gender; 5) laterality of tumor; 6) clinical presentations at diagnosis; 7) disease history; 8) pathologic grade; 9) stage of disease at diagnosis; 10) primary treatment; 11) adjuvant treatment; 12) prognostic outcomes. Disagreements were resolved through discussion. Disease history was defined as kidney disease that patients had before.

Statistical Analysis

OS was defined as the time from the date of diagnosis of Xp11.2 tRCC to death. In the absence of confirmation of death, OS was censored at the last date when the patient was known to be alive. PFS was defined as the time interval between the date of surgery and date of disease recurrence or metastasis. Data on patient demographics, the characteristics of tumors, and treatment approaches were summarized using descriptive statistics. The associations between these factors and OS and PFS of Xp11.2 tRCC were evaluated using univariable and multivariable Cox regression models, and hazard ratios (HR) with 95% confidence intervals (95% CI) and p values are presented. Survival analyses of OS and PFS were generated using the Kaplan-Meier method, and the log-rank test was performed for the significance comparison. Generally, $p < 0.05$ (two-sided) was considered statistically significant. Statistical analyses on survival were performed using SPSS version 19.0 (SPSS, Chicago, IL).

RESULTS

Search Results and Characteristics of the Included Studies

Our search strategy yielded a total of 479 articles. After the screen of abstracts, 152 articles were considered to be relevant reports. After reviewing these articles, we found 80 that reported histopathologically confirmed Xp11.2 tRCC and fulfilled the inclusion criteria (**Figure 1**), giving a total of 415 patients [2], [8–10], [11–20], [21–30], [31–40], [41–50], [51–60], [61–70], [71–86]. Baseline characteristics are summarized in **Table 1**.

Survival Analyses of OS and PFS

The median time of PFS was 72 months (range: 1–321 months; **Figures 2** and 198 months for OS (range: 1–321 months; **Figure 2**). The OS was 74.5 and 69.8% for 3-years and 5-years, respectively.

Univariate and Multivariate Analyses for PFS and OS

In multivariable analyses, the T stage at presentation was significantly associated with PFS (HR: 3.87; 95% CI: 1.70 to 8.84; $p = 0.001$; **Table 2**), which was the only predictive factor for PFS. However, in the multivariable analyses for OS, age at diagnosis (HR: 2.16; 95% CI: 1.03 to 4.50; $p = 0.041$), T stage at presentation (HR: 4.44; 95% CI: 2.16 to 9.09; $p < 0.001$) and metastasis status at presentation (HR: 2.67; 95% CI: 1.12 to 6.41; $p = 0.027$) were all associated with OS (**Table 3**).

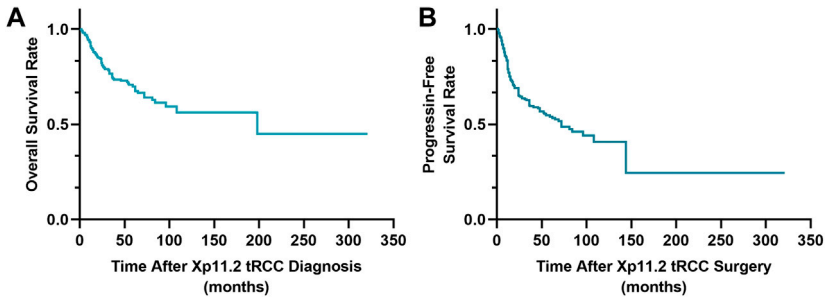

FIGURE 2 | Survival curves of overall survival **(A)** and progression-free survival **(B)**.

TABLE 2 | Univariate and multivariate analyses for variables considered for progression-free survival (Cox proportional hazard regression model).

Variables		Univariate analysis		Multivariate analysis	
		HR (95% CI)	*p*	HR (95% CI)	*p*
Age (>45)		1.57 (1.08–2.29)	0.019	1.57 (0.63–3.96)	0.336
Gender (male)		1.48 (1.07–2.04)	0.019	1.40 (0.65–3.02)	0.391
Laterality (right)		0.68 (0.47–0.98)	0.048	0.66 (0.26–1.67)	0.380
Disease history (Yes)		1.37 (0.63–2.99)	0.426		
Symptomatic (Yes)		1.99 (1.29–3.05)	0.002	0.88 (0.30–2.57)	0.817
T stage at presentation (T3-T4)		5.26 (3.17–7.45)	<0.001	3.87 (1.70–8.84)	0.001
Metastasis (Yes)		6.01 (4.11–8.77)	<0.001	2.24 (0.64–7.81)	0.205
Fuhrman grade (G3-G4)		2.09 (1.28–3.47)	0.004	1.27 (0.43–3.75)	0.666
Surgery approach (RN)		4.87 (2.67–10.45)	<0.001	1.35 (0.37–4.99)	0.653
Adjuvant therapy	TT v none	6.45 (3.95–10.52)	<0.001		
	IT v none	1.55 (0.77–3.13)	1.224		
	CT v none	3.03 (0.90–10.14)	0.072		

TT, targeted therapy; IT, immune therapy; CT, chemotherapy.

Cox Analyses for PFS and OS for Patients in Larger Series

For studies including more than 12 patients, a separate analysis was conducted, involving 11 studies with 218 patients [24, 25, 37, 52, 55, 59, 61, 67, 72, 74, 80]. In multivariable analyses, the T stage at presentation was significantly associated with PFS (HR: 7.73; 95% CI: 3.09 to 19.33; $p < 0.001$; **Supplementary Appendix Table 1**). In the [23, 24, 37, 52, 59, 70], multivariable analyses for OS, T stage at presentation (HR: 7.30; 95% CI: 3.55 to 15.02; $p < 0.001$) and metastasis status at presentation (HR: 2.16; 95% CI: 1.10 to 4.26; $p = 0.026$) were associated with OS (**Supplementary Appendix Table 2**).

DISCUSSION

Xp11.2 tRCC is characterized by several chromosomal translocations involving the TFE3 gene on chromosome Xp11.2. TFE3 gene can be fused by several genes, such as ASPL and SFPQ [87]. However, the same ASPL-TFE3 fusion gene is involved in alveolar soft part sarcoma, which may lead to differences in clinical and morphological features and an imbalance of the translocation mechanism [88, 89]. Also, the function of chimeric TFE3 fusion proteins varies a lot, which may lead to the different histological features in Xp11.2 tRCC [90].

Studies focusing specifically on patients with Xp11.2 tRCC are rare and limited by small samples. This study is the first one to collect the previous relevant studies and investigate the prognostic factors for PFS and OS in patients with Xp11.2 tRCC to our knowledge.

After being recognized as a distinct entity by WHO in 2004, the diagnosis of Xp11.2 tRCC usually depend on microscopic and THE3-IHC. Although Wang et al. in 2017 suggested only part of patients with positive reaction to TFE3-IHC were eventually pathologically diagnosed with Xp11.2 tRCC by FISH assay [80]. Compared with cytogenetics, THE3-IHC is equipped with higher speed and sensitivity of diagnosis, the sensitivity of specificity of which were found to be 97.5 and 99.6%, respectively [89]. Thus, TFE3-IHC can be conducted for screening, and FISH can be conducted for verification.

In reported cases, there was an observed prevalence of females (56.33%), patients under 45 years old (77.67%) and right side (57.99%) from all 80 studies with 415 cases, which is in line with the previous studies with case series [14, 23, 24, 37, 52, 59, 70, 80]. Liu et al. reported 34 patients with Xp11.2 tRCC, where females accounted for 61.8% and people under 18 for 88.2%. Also, in a report by Qu et al. [70], female and right-side cases accounted for 18 and 17 of 30 cases, respectively. Same pattern can be found in rest studies [14, 23, 24, 37, 52, 80]. Since the occurrence of Xp11.2 tRCC involves the translocation of Xp11.2 chromosome, and compared with males, females have one more X chromosome, which may cause higher incidence of this disease. However, it's still not clear why predominance existed in right side.

According to previous studies, Xp11.2 tRCC is more common in children and young adults under 45 years old (low incidence of 0.2–5.0%) [2, 37, 49], but it was found to be more aggressive in adults [91]. In the present study, we found that the age is an independent predictor for the OS in patients with Xp11.2 tRCC (HR: 2.16; 95% CI: 1.03 to 4.50; $p = 0.041$). However, no standard treatment has been raised and radical nephrectomy (RN) is the first choice if possible [92], which accounts for 77.4% of 305 cases with reported surgery approach in the present study. Meanwhile,

TABLE 3 | Univariate and multivariate analyses for variables considered for overall survival (Cox proportional hazard regression model).

Variables		Univariate analysis		Multivariate analysis	
		HR (95% CI)	*p*	HR (95% CI)	*p*
Age (>45)		1.90 (1.19–3.04)	0.007	2.16 (1.03–4.50)	0.041
Gender (male)		1.55 (1.03–2.33)	0.034	1.24 (0.64–2.38)	0.527
Laterality (right)		0.63 (0.39–1.01)	0.053		
Disease history (Yes)		0.70 (0.24–2.02)	0.508		
Symptomatic (Yes)		1.96 (1.16–3.43)	0.012	1.16 (0.59–2.25)	0.664
T stage at presentation (T3-T4)		5.79 (3.68–9.12)	<0.001	4.44 (2.16–9.09)	<0.001
Metastasis (Yes)		5.27 (3.29–8.45)	<0.001	2.67 (1.12–6.41)	0.027
Fuhrman grade (G3-G4)		1.11 (0.61–2.02)	0.741		
Surgery approach (RN)		3.6 (1.46–8.96)	0.005	3.95 (0.93–16.78)	0.063
Adjuvant therapy	TT v none	3.31 (1.78–6.17)	<0.001		
	IT v none	1.86 (0.86–3.99)	1.113		
	CT v none	4.51 (1.51–13.52)	0.007		

TT, targeted therapy; IT, immune therapy; CT, chemotherapy.

RN was reported to have beneficial outcomes in the treatment of patients as well. Dai reported eight patients with the treatment of RN who had a median PFS of 32 months in 2018 [25]. In multivariate analyses in present study, there is no significantly association between surgery approach and prognosis in Xp11.2 tRCC patients, and there's still lack of long-time follow-up due to its late recurrence [93]. In a study of Liu et al. in 2017, all nine patients were treated with partial nephrectomy (PN), with a median PFS of 51 months [57]. In previous studies, RN was reported to be associated with an increased risk of postoperative complications, and PN has been proposed to achieve a better overall survival result in patients with RCC [94, 95]. Thus, PN can be considered as a main approach in the treatment of Xp11.2 tRCC.

In this study, we found that pT status, which was reported to contribute to the advanced TNM stage [96], is significantly associated with both PFS and OS in Xp11.2 tRCC patients. Furthermore, it's suggested that TNM stage is the most significant factors associated with poor prognosis in Xp11.2 tRCC patients, in the study with 34 patients of Liu in 2016 [59]. Meyer reported three patients who were in the late stage of Xp11.2 tRCC and had metastasis, ending up with an average time of 18 months for OS regardless of the adjuvant therapy [63].

With regard to the adjuvant treatment, there is still no data mentioning the most optimal or reliable treatment for each individual patient. In univariate analyses in the present study, patients treated with targeted therapy seemed to achieve a better result in both OS and PFS. Due to the close relationship between the choice of adjuvant treatment and TNM stage, in order to reach a more reliable result, we didn't include the adjuvant treatment into the multivariable Cox regression models. Targeted therapy, immunotherapy and chemotherapy are the main options in included studies, which accounts for 53.2, 40.3 and 6.5% in the cases with reported adjuvant treatment in the present study. Targeted therapy, including sunitinib and sorafenib, was more likely to be chosen in patients with metastases [70]. Malouf reported two groups of patients with metastatic Xp11.2 tRCC, where one group with seven patients were treated with sunitinib, and the other one with 14 patients treated with immune therapy, showing a median PFS of 8 and 2 months respectively. Moreover, in the study of Wang in 2018, the DNA and RNA sequencing of Xp11 tRCC were reported, revealing novel gene fusions and presenting other potential targets for treatment [87]. Recent studies have shown that vascular endothelial growth factor receptor-targeted agents and mammalian target of rapamycin inhibitors play an important role effects in the treatment of metastatic TFE3 RCC [97–101]. Other targeted agents and immune checkpoint inhibitors are currently being tested and developed [102–104].

There are some limitations in our study. First, we included cases diagnosed with TFE3-IHC or FISH both in order to obtain a sufficient sample size, which may also lead to potential misdiagnoses. Second, because Xp11.2 tRCC is unpopular and underestimated in adults, and the information provided in the studies were insufficient and retrospective, the results should be interpreted discreetly. Third, due to the insufficient data in previous studies, when only the status of PFS was provided and evidence showed that the patient was alive, the survival data was converted to OS, which may not be precise. Fourth, age was considered as a prognosis factor for OS in analysis for all cases, but wasn't a significant factor in the separate analysis for larger series, which can be attributed to the selection bias brought by case reports. Also, variance may exist due to the different settings from researchers in different cases. However, the results of the present study are still beneficial for the further research and understanding of the factors associated with survival from Xp11.2 tRCC.

In conclusion, T stage at presentation is the only factor that is associated with both PFS and OS in patients with Xp11.2 tRCC. Also, patients over 45 or with metastases are more likely to have poorer OS. Additional studies are still needed for the identification of potential targets for novel therapies.

AUTHOR CONTRIBUTIONS

YW: Conceptualization, Methodology SC: Resources, Writing–Original draft preparation. MZ: Software KL: Writing–Review and Editing BX: Supervision. MC: Funding acquisition.

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CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.por-journal.com/articles/10.3389/pore.2021.610360/full#supplementary-material.

REFERENCES

1. Eble JN, Sauter GInternational Agency for Research on Cancer. *Pathology and genetics of Tumors of the urinary system and male genital organs*. Lyon, France: IARC Press (2004): 359.
2. Hirobe M, Masumori N, Tanaka T, Kitamura H, Tonooka A, Hasegawa T, et al. Clinicopathological characteristics of Xp11.2 translocation renal cell carcinoma in adolescents and adults: diagnosis using immunostaining of transcription factor E3 and fluorescence *in situ* hybridization analysis. *Int J Urol* (2016). 23(2): 140–5. doi:10.1111/iju.13007
3. Argani P, Ladanyi M. Translocation carcinomas of the kidney. *Clin Lab Med* (2005). 25:363–78. doi:10.1016/j.cll.2005.01.008
4. Argani P, Laé M, Hutchinson B, Reuter VE, Collins MH, Perentesis J, et al. Renal carcinomas with the t(6;11)(p21;q12): clinicopathologic features and demonstration of the specific alpha-TFEB gene fusion by immunohistochemistry, RT-PCR, and DNA PCR. *Am J Surg Pathol* (2005). 29(2):230–40. doi:10.1097/01.pas.0000146007.54092.37
5. Pan CC, Sung MT, Huang HY, Yeh KT. High chromosomal copy number alterations in Xp11 translocation renal cell carcinomas detected by array comparative genomic hybridization are associated with aggressive behavior. *Am J Surg Pathol* (2013). 37(7):1116–9. doi:10.1097/PAS.0b013e318293d872
6. Moch H, Reuter VE. *WHO classification of tumours of the urinary system and male genital organs*. Lyon, France: International Agency for Research on Cancer (2016): 356.
7. Malouf GG, Camparo P, Molinié V, Dedet G, Oudard S, Schleiermacher G, et al. Transcription factor E3 and transcription factor EB renal cell carcinomas: clinical features, biological behavior and prognostic factors. *J Urol* (2011). 185(1):24–9. doi:10.1016/j.juro.2010.08.092
8. Rao Q, Williamson SR, Zhang S, Eble JN, Grignon DJ, Wang M, et al. TFE3 break-apart FISH has a higher sensitivity for Xp11.2 translocation-associated renal cell carcinoma compared with TFE3 or cathepsin K immunohistochemical staining alone: expanding the morphologic spectrum. *Am J Surg Pathol* (2013). 37:804–15. doi:10.1097/PAS.0b013e31827e17cb
9. Ahluwalia P, Nair B, Kumar G. Renal cell carcinoma associated with Xp11.2 translocation/TFE3 gene fusion: a rare case report with review of the literature. *Case Rep Urol* (2013). 2013:810590. doi:10.1155/2013/810590
10. Altinok G, Kattar MM, Mohamed A, Poulik J, Grignon D, Rabah R. Pediatric renal carcinoma associated with Xp11.2 translocations/TFE3 gene fusions and clinicopathologic associations. *Pediatr Dev Pathol* (2005). 8(2):168–80. doi:10.1007/s10024-004-9106-3
11. Antic T, Taxy JB, Alikhan M, Segal J. Melanotic translocation renal cell carcinoma with a novel ARID1B-TFE3 gene fusion. *Am J Surg Pathol* (2017). 41:1576–1580. doi:10.1097/PAS.0000000000000927
12. Aoyagi T, Shinohara N, Kubota-Chikai K, Kuroda N, Nonomura K. Long-term survival in a patient with node-positive adult-onset Xp11.2 translocation renal cell carcinoma. *Urol Int* (2011). 86(4):487–90. doi:10.1159/000323866
13. Argani P, Antonescu CR, Couturier J, Fournet JC, Sciot R, Debiec-Rychter M, et al. PRCC-TFE3 renal carcinomas: morphologic, immunohistochemical, ultrastructural, and molecular analysis of an entity associated with the t(X;1)(p11.2;q21). *Am J Surg Pathol* (2002). 26(12):1553–66. doi:10.1097/00000478-200212000-00003
14. Argani P, Olgac S, Tickoo SK, Goldfischer M, Moch H, Chan DY, et al. Xp11 translocation renal cell carcinoma in adults: expanded clinical, pathologic, and genetic spectrum. *Am J Surg Pathol* (2007). 31(8):1149–60. doi:10.1097/PAS.0b013e318031ffff
15. Argani P, Zhang L, Reuter VE, Tickoo SK, Antonescu CR. RBM10-TFE3 renal cell carcinoma: a potential diagnostic pitfall due to cryptic intrachromosomal Xp11.2 inversion resulting in false-negative TFE3 FISH. *Am J Surg Pathol* (2017). 41:655–662. doi:10.1097/PAS.0000000000000835
16. Argani P, Zhong M, Reuter VE, Fallon JT, Epstein JI, Netto GJ, et al. TFE3-Fusion variant analysis defines specific clinicopathologic associations among Xp11 translocation cancers. *Am J Surg Pathol* (2020). 40:723–37. doi:10.1097/PAS.0000000000000631
17. Armah HB, Parwani AV, Surti U, Bastacky SI. Xp11.2 translocation renal cell carcinoma occurring during pregnancy with a novel translocation involving chromosome 19: a case report with review of the literature. *Diagn Pathol* (2009). 4:15. doi:10.1186/1746-1596-4-15
18. Arnoux V, Long JA, Fiard G, Pasquier D, Bensaadi L, Terrier N, et al. [Xp11.2 translocation renal carcinoma in adults over 50 years of age: about four cases]. *Prog Urol* (2012). 22(15):932–7. doi:10.1016/j.purol.2012.06.009
19. Barroca H, Castedo S, Vieira J, Teixeira M, Müller-Höcker J. Altered expression of key cell cycle regulators in renal cell carcinoma associated with Xp11.2 translocation. *Pathol Res Pract* (2009). 205(7):466–72. doi:10.1016/j.prp.2009.01.005
20. Bovio IM, Allan RW, Oliai BR, Hampton T, Rush DS. Xp11.2 translocation renal carcinoma with placental metastasis: a case report. *Int J Surg Pathol* (2011). 19(1):80–3. doi:10.1177/1066896908331231
21. Brassesco MS, Valera ET, Bonilha TA, Scrideli CA, Carvalho de Oliveira J, Pezuk JA, et al. Secondary PSF/TFE3-associated renal cell carcinoma in a child treated for genitourinary rhabdomyosarcoma. *Cancer Genet* (2011). 204(2): 108–10. doi:10.1016/j.cancergencyto.2010.10.006
22. Cheng X, He J, Gan W, Fan X, Yang J, Zhu B, et al. Pseudocapsule of renal cell carcinoma associated with Xp11.2 translocation/TFE3 gene fusion: a clue for tumor enucleation?. *Int J Clin Exp Pathol* (2015). 8(5):5403–10 .
23. Choueiri TK, Mosquera JM, Hirsch MS. A case of adult metastatic Xp11 translocation renal cell carcinoma treated successfully with sunitinib. *Clin Genitourin Cancer* (2009). 7(3):E93–4. doi:10.3816/CGC.2009.n.031
24. Classe M, Malouf GG, Su X, Yao H, Thompson EJ, Doss DJ, et al. Incidence, clinicopathological features and fusion transcript landscape of translocation renal cell carcinomas. *Histopathology* (2017). 70(7):1089–1097. doi:10.1111/his.13167
25. Dai C, Sheng R, Ding Y, Yang M, Hou J, Zhou J. Magnetic resonance imaging findings of renal cell carcinoma associated with Xp11.2 translocation/TFE3 gene fusion in adults: a pilot study. *Abdom Radiol (NY)* (2019). 44(1):209–217. doi:10.1007/s00261-018-1703-0
26. Dang TT, Ziv E, Weinstein S, Meng MV, Wang Z, Coakley FV. Computed tomography and magnetic resonance imaging of adult renal cell carcinoma associated with Xp11.2 translocation. *J Comput Assist Tomogr* (2012). 36(6): 669–74. doi:10.1097/RCT.0b013e3182680182
27. Dey B, Badhe B, Govindarajan KK, Ramesh RA. Xp11.2 translocation renal cell carcinoma diagnosed by immunohistochemistry and cytogenetics. *J Lab Physicians* (2016). 8(2):123–5. doi:10.4103/0974-2727.180796

28. Driss M, Boukadi A, Charfi L, Douira W, Mrad K, Bellagha I, et al. Renal cell carcinoma associated with Xp11.2 translocation arising in a horseshoe kidney. *Pathology* (2009). 41(6):587–90. doi:10.1080/00313020903071496
29. El Naili R, Nicolas M, Gorena A, Policarpio-Nicolas ML. Fine-needle aspiration findings of Xp11 translocation renal cell carcinoma metastatic to a hilar lymph node. *Diagn Cytopathol* (2017). 45(5):456–462. doi:10.1002/dc.23676
30. Fukuda H, Kato I, Furuya M, Tanaka R, Takagi T, Kondo T, et al. A novel partner of TFE3 in the Xp11 translocation renal cell carcinoma: clinicopathological analyses and detection of EWSR1-TFE3 fusion. *Virchows Arch* (2019). 474(3):389–393. doi:10.1007/s00428-018-2509-8
31. Ge L, Tian X, Ma J, Zhao G, Song Y, Zhang S, et al. Surgical treatment for Xp11.2 translocation renal cell carcinoma with venous thrombus: a STROBE-compliant study. *Medicine (Baltimore)* (2019). 98(37):e17172. doi:10.1097/MD.0000000000017172
32. Gong P, Zhuang Q, Wang K, Xu R, Chen Y, Wang X, et al. Adult-onset renal cell carcinoma associated with Xp11.2 translocation/TFE3 gene fusion: 3 case reports and review of literature. *Medicine (Baltimore)* (2018). 97(24):e11023. doi:10.1097/MD.0000000000011023
33. Gorin MA, Ball MW, Pierorazio PM, Argani P, Allaf ME. Partial nephrectomy for the treatment of translocation renal cell carcinoma. *Clin Genitourin Cancer* (2015). 13(3):e199–201. doi:10.1016/j.clgc.2014.12.008
34. Green WM, Yonescu R, Morsberger L, Morris K, Netto GJ, Epstein JI, et al. Utilization of a TFE3 break-apart FISH assay in a renal tumor consultation service. *Am J Surg Pathol* (2013). 37(8):1150–63. doi:10.1097/PAS.0b013e31828a69ae
35. Haudebourg J, Hoch B, Fabas T, Burel-Vandenbos F, Carpentier X, Amiel J, et al. A novel case of t(X;1)(p11.2;p34) in a renal cell carcinoma with TFE3 rearrangement and favorable outcome in a 57-year-old patient. *Cancer Genet Cytogenet* (2010). 200(2):75–8. doi:10.1016/j.cancergencyto.2010.03.011
36. Hayes M, Peckova K, Martinek P, Hora M, Kalusova K, Straka L, et al. Molecular-genetic analysis is essential for accurate classification of renal carcinoma resembling Xp11.2 translocation carcinoma. *Virchows Arch* (2015). 466(3):313–22. doi:10.1007/s00428-014-1702-7
37. He J, Chen X, Gan W, Zhu B, Fan X, Guo H, et al. Renal cell carcinoma associated with Xp11.2 translocation/TFE3 gene fusions: clinical experience and literature review. *Future Oncol* (2015). 11(24):3243–52. doi:10.2217/fon.15.177
38. Hou MM, Hsieh JJ, Chang NJ, Huang HY, Wang HM, Chuang CK, et al. Response to sorafenib in a patient with metastatic xp11 translocation renal cell carcinoma. *Clin Drug Investig* (2010). 30(11):799–804. doi:10.2165/11537220-000000000-00000
39. Hung CC, Pan CC, Lin CC, Lin AT, Chen KK, Chang YH. XP11.2 translocation renal cell carcinoma: clinical experience of Taipei Veterans General Hospital. *J Chin Med Assoc* (2011). 74(11):500–4. doi:10.1016/j.jcma.2011.09.005
40. Jayasinghe C, Siegler N, Leuschner I, Fleischhack G, Born M, Müller AM. Renal cell carcinoma with Xp11.2 translocation in a 7-year-old boy. *Klin Padiatr* (2010). 222(3):187–9. doi:10.1055/s-0030-1252011
41. Jing H, Tai Y, Xu D, Yang F, Geng M. Renal cell carcinoma associated with Xp11.2 translocations, report of a case. *Urology* (2010). 76(1):156–8. doi:10.1016/j.urology.2009.07.1276
42. Jin M, Parwani A, Li Z, Wakely PE. Cytopathology of Xp11 translocation renal cell carcinoma: a report of 5 cases. *J Am Soc Cytopathol* (2020). 9 (2):95–102. doi:10.1016/j.jasc.2019.10.005
43. Wang W, Ding J, Li Y, Wang C, Zhou L, Zhu H, et al. Magnetic resonance imaging and computed tomography characteristics of renal cell carcinoma associated with Xp11.2 translocation/TFE3 gene fusion. *Plos One* (2014). 9(6):e99990. doi:10.1371/journal.pone.0099990
44. Kakoki K, Miyata Y, Mochizuki Y, Iwata T, Obatake M, Abe K, et al. Long-term treatment with sequential molecular targeted therapy for Xp11.2 translocation renal cell carcinoma: a case report and review of the literature. *Clin Genitourin Cancer* (2017). 15(3):e503–e506. doi:10.1016/j.clgc.2016.12.026
45. Karashima T, Kuno T, Kuroda N, Satake H, Fukata S, Chikazawa M, et al. Bilateral Xp11.2 translocation renal cell carcinoma: a case report. *BMC Urol* (2018). 18(1):106. doi:10.1186/s12894-018-0419-3
46. Kato I, Furuya M, Baba M, Kameda Y, Yasuda M, Nishimoto K, et al. RBM10-TFE3 renal cell carcinoma characterised by paracentric inversion with consistent closely split signals in break-apart fluorescence *in-situ* hybridisation: study of 10 cases and a literature review. *Histopathology* (2019). 75(2):254–265. doi:10.1111/his.13866
47. Kmetec A, Jeruc J. Xp 11.2 translocation renal carcinoma in young adults; recently classified distinct subtype. *Radiol Oncol* (2014). 48(2):197–202. doi:10.2478/raon-2013-0077
48. Koie T, Yoneyama T, Hashimoto Y, Kamimura N, Kusumi T, Kijima H, et al. An aggressive course of Xp11 translocation renal cell carcinoma in a 28-year-old man. *Int J Urol* (2009). 16(3):333–5. doi:10.1111/j.1442-2042.2008.02231.x
49. Komai Y, Fujiwara M, Fujii Y, Mukai H, Yonese J, Kawakami S, et al. Adult Xp11 translocation renal cell carcinoma diagnosed by cytogenetics and immunohistochemistry. *Clin Cancer Res* (2009). 15(4):1170–6. doi:10.1158/1078-0432.CCR-08-1183
50. Koo HJ, Choi HJ, Kim MH, Cho KS. Radiologic-pathologic correlation of renal cell carcinoma associated with Xp11.2 translocation. *Acta Radiol* (2013). 54(7):827–34. doi:10.1177/0284185113484019
51. Kuroda N, Tamura M, Tanaka Y, Hes O, Michal M, Inoue K, et al. Adult-onset renal cell carcinoma associated with Xp11.2 translocations/TFE3 gene fusion with smooth muscle stroma and abnormal vessels. *Pathol Int* (2009). 59(7):486–91. doi:10.1111/j.1440-1827.2009.02398.x
52. Kuthi L, Somorácz Á, Micsik T, Jenei A, Hajdu A, Sejben I, et al. Clinicopathological findings on 28 cases with XP11.2 renal cell carcinoma. *Pathol Oncol Res* (2020). 26:2123–2133. doi:10.1007/s12253-019-00792-0
53. Michalova K, Tretiakova M, Pivovarcikova K, Alaghehbandan R, Perez Montiel D, Ulamec M, et al. Expanding the morphologic spectrum of chromophobe renal cell carcinoma: a study of 8 cases with papillary architecture. *Ann Diagn Pathol* (2020). 44:151448. doi:10.1016/j.anndiagpath.2019.151448
54. Liang W, Xu S. Xp11.2 translocation renal cell carcinoma with egg-shell calcification mimicking a benign renal tumour: a case report. *Oncol Lett* (2015). 10(5):3191–3194. doi:10.3892/ol.2015.3718
55. Lim B, You D, Jeong IG, Kwon T, Hong S, Song C, et al. Clinicopathological features of Xp11.2 translocation renal cell carcinoma. *Korean J Urol* (2015). 56(3):212–7. doi:10.4111/kju.2015.56.3.212
56. Iinuma K, Kojima K, Okamoto K, Yuhara K. [A case of Xp.11.2 traslocational renal cell carcinoma diagnosed by fluorescence *in Situ* hybridization (FISH)]. *Hinyokika kiyo* (2016). 62:411–4. doi:10.14989/ActaUrolJap_62_8_411
57. Liu C, Zhang W, Song H. Nephron-sparing surgery in the treatment of pediatric renal cell carcinoma associated with Xp11.2 translocation/TFE3 gene fusions. *J Pediatr Surg* (2017). 52(9):1492–1495. doi:10.1016/j.jpedsurg.2017.03.052
58. Liu J, Su Z, Li Y, Chen D, Ni L, Mao X, et al. Xp11.2 translocation renal cell carcinoma with multiple bone metastases: a case report. *Oncol Lett* (2016). 11(3):2233–2236. doi:10.3892/ol.2016.4211
59. Liu N, Wang Z, Gan W, Xiong L, Miao B, Chen X, et al. Renal cell carcinoma associated with Xp11.2 translocation/TFE3 gene fusions: clinical features, treatments and prognosis. *PLoS One* (2016). 11(11):e0166897. doi:10.1371/journal.pone.0166897
60. Ma J, Pan C, Yin M. Translocation renal cell carcinoma in a child previously treated for infantile fibrosarcoma. *Pediatr Dev Pathol* (2018). 21(4):418–422. doi:10.1177/1093526617707849
61. Malouf GG, Camparo P, Oudard S, Schleiermacher G, Theodore C, Rustine A, et al. Targeted agents in metastatic Xp11 translocation/TFE3 gene fusion renal cell carcinoma (RCC): a report from the Juvenile RCC Network. *Ann Oncol* (2010). 21(9):1834–8. doi:10.1093/annonc/mdq029
62. Masago T, Kobayakawa S, Ohtani Y, Taniguchi K, Naka T, Kuroda N, et al. Xp11.2 translocation renal cell carcinoma with TFE3 gene fusion in the elderly: case report and literature review. *Int Cancer Conf J* (2020). 9(4), 182–186. doi:10.1007/s13691-020-00430-6
63. Meyer PN, Clark JI, Flanigan RC, Picken MM. Xp11.2 translocation renal cell carcinoma with very aggressive course in five adults. *Am J Clin Pathol* (2007). 128(1):70–9. doi:10.1309/LR5G1VMXPY3G0CUK
64. Mir MC, Trilla E, de Torres IM, Panizo A, Zlotta AR, Van Rhijn B, et al. Altered transcription factor E3 expression in unclassified adult renal cell

carcinoma indicates adverse pathological features and poor outcome. *BJU Int* (2011). 108(2):E71–6. doi:10.1111/j.1464-410X.2010.09818.x
65. Morii A, Fujiuchi Y, Nomoto K, Komiya A, Fuse H. Rapidly progressing renal cell carcinoma associated with Xp11.2 translocations: a case report. *J Med Case Rep* (2012). 6:164. doi:10.1186/1752-1947-6-164
66. Nishimura K, Takagi T, Toda N, Yamamoto T, Kondo T, Ishida H, et al. A case of metastatic Xp11.2 translocation renal cell carcinoma successfully managed by cytoreductive nephrectomy followed by axitinib therapy. *Mol Clin Oncol* (2017). 6(3):362–364. doi:10.3892/mco.2017.1142
67. Pan X, Quan J, Zhao L, Li W, Wei B, Yang S, et al. Xp11.2 translocation renal cell carcinoma with TFE3 gene fusion: a case report. *Mol Clin Oncol* (2018). 8(1):83–85. doi:10.3892/mco.2017.1497
68. Parikh J, Coleman T, Messias N, Brown J. Temsirolimus in the treatment of renal cell carcinoma associated with Xp11.2 translocation/TFE gene fusion proteins: a case report and review of literature. *Rare Tumors* (2009). 1(2):e53. doi:10.4081/rt.2009.e53
69. Pwint TP, Macaulay V, Roberts IS, Sullivan M, Protheroe A. An adult Xp11.2 translocation renal carcinoma showing response to treatment with sunitinib. *Urol Oncol* (2011). 29(6):821–4. doi:10.1016/j.urolonc.2009.10.007
70. Qu Y, Gu C, Wang H, Chang K, Yang X, Zhou X, et al. Diagnosis of adults Xp11.2 translocation renal cell carcinoma by immunohistochemistry and FISH assays: clinicopathological data from ethnic Chinese population. *Sci Rep* (2016). 6:21677. doi:10.1038/srep21677
71. Rais-Bahrami S, Drabick JJ, De Marzo AM, Hicks J, Ho C, Caroe AE, et al. Xp11 translocation renal cell carcinoma: delayed but massive and lethal metastases of a chemotherapy-associated secondary malignancy. *Urology* (2007). 70(1), 178–6. doi:10.1016/j.urology.2007.03.037
72. Rao Q, Chen JY, Wang JD, Ma HH, Zhou HB, Lu ZF, et al. Renal cell carcinoma in children and young adults: clinicopathological, immunohistochemical, and VHL gene analysis of 46 cases with follow-up. *Int J Surg Pathol* (2011). 19(2):170–9. doi:10.1177/1066896909354337
73. Rua Fernández OR, Escala Cornejo R, Navarro Martín M, García Muñoz M, Antunez Plaza P, García Dominguez AR, et al. Renal cell carcinoma associated with Xp11.2 translocation/TFE3 gene-fusion: a long response to mammalian target of rapamycin (mTOR) inhibitors. *Urology* (2018). 117:41–43. doi:10.1016/j.urology.2018.03.032
74. Song HC, Sun N, Zhang WP, He L, Fu L, Huang C. Biological characteristics of pediatric renal cell carcinoma associated with Xp11.2 translocations/TFE3 gene fusions. *J Pediatr Surg* (2014). 49(4):539–42. doi:10.1016/j.jpedsurg.2013.10.005
75. Su HH, Sung MT, Chiang PH, Cheng YT, Chen YT. The preliminary experiences of translocation renal cell carcinoma and literature review. *Kaohsiung J Med Sci* (2014). 30(8):402–8. doi:10.1016/j.kjms.2014.03.003
76. Sudour-Bonnange H, Leroy X, Chauvet MP, Classe M, Robin PM, Leblond P. Cutaneous metastases during an aggressive course of Xp11.2 translocation renal cell carcinoma in a teenager. *Pediatr Blood Cancer* (2014). 61(9):1698–700. doi:10.1002/pbc.25015
77. Sukov WR, Hodge JC, Lohse CM, Leibovich BC, Thompson RH, Pearce KE, et al. TFE3 rearrangements in adult renal cell carcinoma: clinical and pathologic features with outcome in a large series of consecutively treated patients. *Am J Surg Pathol* (2012). 36(5):663–70. doi:10.1097/PAS.0b013e31824dd972
78. Taskinlar H, Avlan D, Citak C, Polat A, Nayci A. A rare cause of childhood renal cysts: Xp11.2 translocation renal cell carcinoma. *Can Urol Assoc J* (2015). 9(1-2):E36–38. doi:10.5489/cuaj.2321
79. Wang Y, Wang Y, Feng M, Lian X, Lei Y, Zhou H. Renal cell carcinoma associated with Xp11.2 translocation/transcription factor E3 gene fusion: an adult case report and literature review. *J Int Med Res* (2020). 48:300060520942095. doi:10.1177/0300060520942095
80. Wang Z, Liu N, Gan W, Li X, Zhang G, Li D, et al. Postoperative recurrence of adult renal cell carcinoma associated with Xp11.2 translocation/TFE3 gene fusion. *J Int Med Res* (2017). 45(4):1287–1296. doi:10.1177/0300060517711358
81. Xia QY, Wang XT, Zhan XM, Tan X, Chen H, Liu Y, et al. Xp11 translocation renal cell carcinomas (RCCs) with RBM10-TFE3 gene fusion demonstrating melanotic features and overlapping morphology with t(6;11) RCC: interest and diagnostic pitfall in detecting a paracentric inversion of TFE3. *Am J Surg Pathol* (2017). 41(5):663–676. doi:10.1097/PAS.0000000000000837
82. Xia QY, Wang Z, Chen N, Gan HL, Teng XD, Shi SS, et al. Xp11.2 translocation renal cell carcinoma with NONO-TFE3 gene fusion: morphology, prognosis, and potential pitfall in detecting TFE3 gene rearrangement. *Mod Pathol* (2017). 30(3):416–426. doi:10.1038/modpathol.2016.204
83. Xu L, Yang R, Wang W, Zhang Y, Gan W. Laparoscopic radiofrequency ablation-assisted enucleation of Xp11.2 translocation renal cell carcinoma: a case report. *Oncol Lett* (2014). 8(3):1237–1239. doi:10.3892/ol.2014.2267
84. Zhong M, De Angelo P, Osborne L, Paniz-Mondolfi AE, Geller M, Yang Y, et al. Translocation renal cell carcinomas in adults: a single-institution experience. *Am J Surg Pathol* (2012). 36(5):654–62. doi:10.1097/PAS.0b013e31824f24a6
85. Zhu G, Qiu X, Chen X, Liu G, Zhang G, Gan W, et al. Cardiopulmonary bypass-assisted surgery for the treatment of Xp11.2 translocation/TFE3 gene fusion renal cell carcinoma with a tumor thrombus within the inferior vena cava: a case report. *Oncol Lett* (2015). 10(6):3532–3534. doi:10.3892/ol.2015.3739
86. Zou H, Kang X, Pang LJ, Hu W, Zhao J, Qi Y, et al. Xp11 translocation renal cell carcinoma in adults: a clinicopathological and comparative genomic hybridization study. *Int J Clin Exp Pathol* (2014). 7(1):236–45. doi:10.1016/j.prp.2014.02.001
87. Wang XT, Xia QY, Ye SB, Wang X, Li R, Fang R, et al. RNA sequencing of Xp11 translocation-associated cancers reveals novel gene fusions and distinctive clinicopathologic correlations. *Mod Pathol* (2018). 31;1346–1360. doi:10.1038/s41379-018-0051-5
88. Huang HY, Lui MY, Ladanyi M. Nonrandom cell-cycle timing of a somatic chromosomal translocation: the t(X;17) of alveolar soft-part sarcoma occurs in G2. *Genes Chromosomes Cancer* (2005). 44(2):170–6. doi:10.1002/gcc.20229
89. Argani P, Lal P, Hutchinson B, Lui MY, Reuter VE, Ladanyi M. Aberrant nuclear immunoreactivity for TFE3 in neoplasms with TFE3 gene fusions: a sensitive and specific immunohistochemical assay. *Am J Surg Pathol* (2003). 27:750–61. doi:10.1097/00000478-200306000-00005
90. Caliò A, Segala D, Munari E, Brunelli M, Martignoni G. MiT family translocation renal cell carcinoma: from the early descriptions to the current knowledge. *Cancers* (2019). 11(8):1110. doi:10.3390/cancers11081110
91. Asaki HE, Moshero G, Stanton ML, Humphreys MR. Xp11.2 translocation tumor: a rare cause of gross hematuria. *JAAPA* (2014). 27(2):24–7. doi:10.1097/01.JAA.0000442700.87975.0b
92. Kuroda N, Mikami S, Pan CC, Cohen RJ, Hes O, Michal M, et al. Review of renal carcinoma associated with Xp11.2 translocations/TFE3 gene fusions with focus on pathobiological aspect. *Histol Histopathol* (2012). 27(2):133–40. doi:10.14670/HH-27.133
93. Ellis CL, Eble JN, Subhawong AP, Martignoni G, Zhong M, Ladanyi M, et al. Clinical heterogeneity of Xp11 translocation renal cell carcinoma: impact of fusion subtype, age, and stage. *Mod Pathol* (2014). 27(6):875–86. doi:10.1038/modpathol.2013.208
94. Kim SP, Campbell SC, Gill I, Lane BR, Van Poppel H, Smaldone MC, et al. Collaborative review of risk benefit trade-offs between partial and radical nephrectomy in the management of anatomically complex renal masses. *Eur Urol* (2017). 72(1):64–75. doi:10.1016/j.eururo.2016.11.038
95. Tan HJ, Norton EC, Ye Z, Hafez KS, Gore JL, Miller DC. Long-term survival following partial vs radical nephrectomy among older patients with early-stage kidney cancer. *JAMA* (2012). 307(15):1629–35. doi:10.1001/jama.2012.475
96. Agizamhan S, Qu F, Liu N, Sun J, Xu W, Zhang L, et al. Preoperative neutrophil-to-lymphocyte ratio predicts the surgical outcome of Xp11.2 translocation/TFE3 renal cell carcinoma patients. *BMC Urol* (2018). 18(1):60. doi:10.1186/s12894-018-0374-z
97. Kakoki K, Miyata Y, Mochizuki Y, Iwata T, Obatake M, Abe K, et al. Long-term treatment with sequential molecular targeted therapy for Xp11.2 translocation renal cell carcinoma: a case report and review of the literature. *Clin Genitourin Cancer* (2017). 15(3):e503–06. doi:10.1016/j.clgc.2016.12.026

98. Choueiri TK, Lim ZD, Hirsch MS, Tamboli P, Jonasch E, McDermott DF, et al. Vascular endothelial growth factor-targeted therapy for the treatment of adult metastatic Xp11.2 translocation renal cell carcinoma. *Cancer* (2010). 116(22): 5219–25. doi:10.1002/cncr.25512
99. Kauffman EC, Lang M, Rais-Bahrami S, et al. Preclinical efficacy of dual mTORC1/2 inhibitor AZD8055 in renal cell carcinoma harboring a TFE3 gene fusion. *BMC Cancer* (2019). 19(1):917. doi:10.1186/s12885-019-6096-0
100. Rua Fernández OR, Escala Cornejo R, Navarro Martín M, García Muñoz M, Antunez Plaza P, García Dominguez AR, et al. Renal cell carcinoma associated with Xp11.2 translocation/TFE3 gene-fusion: a long response to mammalian target of rapamycin (mTOR) inhibitors. *Urology* (2018). 117: 41–43. doi:10.1016/j.urology.2018.03.032
101. Caliò A, Brunelli M, Segala D, Pedron S, Remo A, Ammendola S, et al. Comprehensive analysis of 34 MiT family translocation renal cell carcinomas and review of the literature: investigating prognostic markers and therapy targets. *Pathology* (2020). 52(3):297–309. doi:10.1016/j.pathol.2019.11.006
102. Chipollini J, Azizi M, Peyton CC, Tang DH, Dhillon J, Spiess PE. Implications of programmed death ligand-1 positivity in non-clear cell renal cell carcinoma. *J Kidney Cancer VHL* (2018). 5(4):6–13. doi:10.15586/jkcvhl.2018.107
103. Damayanti NP, Budka JA, Khella HWZ, Ferris MW, Ku SY, Kauffman E, et al. Therapeutic targeting of TFE3/IRS-1/PI3K/mTOR Axis in translocation renal cell carcinoma. *Clin Cancer Res* (2018). 24 (23):5977–5989. doi:10.1158/1078-0432.CCR-18-0269
104. Chang K, Qu Y, Dai B, Zhao JY, Gan H, Shi G, et al. PD-L1 expression in Xp11.2 translocation renal cell carcinoma: indicator of tumor aggressiveness. *Sci Rep* (2017). 7(1):2074. doi:10.1038/s41598-017-02005-7

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