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COVID-19 Pandemic Impact on Uro-Oncological Disease Outcomes at a German Referral Center

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Uro-oncology · Pathological outcomes · Cancer · COVID-19 · Delay

Abstract
Introduction: To assess differences in referral and pathologic outcomes for uro-oncology cases prior to, during, and after the COVID-19 pandemic, comparing clinical and pathological data from cancer surgeries performed at a university medical center between 2018 and 2023. ***Methods:*** We collected data of 212 patients with radical prostatectomy (RP) for prostate cancer, 157 patients with radical cystectomies (RCs) for bladder cancer, 36 patients with radical nephroureterectomies (RNUs) for upper tract urothelial carcinoma, 133 patients with partial nephrectomies (PNs), and 160 patients with radical nephrectomies (RNs) for renal cancer, 93 patients with orchifunicolectomy for testicular cancer, 39 patients with newly diagnosed penile cancer. Data from patients treated between 2018 and February 2020 (before the COVID-19 pandemic) were compared with data from patients treated between March 2020 and March 2022 (during the COVID-19 pandemic) and between April 2022 and February 2023 (after the COVID-19 pandemic). ***Results:*** No differences in terms of main pathologic features were observed in patients undergoing RP, RNU, orchifunicolectomy, or circumcision and/or penectomy. Further, a lower pathological tumor stage was diagnosed for RN after the COVID-19 pandemic ($p < 0.05$). A higher age at diagnosis for penile cancer was observed during the pandemic cohort in comparison to the pre-COVID-19 pandemic cohort ($p < 0.05$), but this did not translate into a worse pathological stage or lymph node involvement. Another notable change was the shortening of the length of stay (LOS) for orchifunicolectomy over the pandemic ($p < 0.05$). ***Conclusion:*** Neither decline in uro-oncologic activity nor pathological features were observed at our institution before, during, and after the COVID-19 pandemic. A significantly lower pathological tumor stage for RN after the COVID-19 pandemic was seen. Penile cancer was diagnosed at a significantly higher age during the COVID-19 pandemic, and a decrease in LOS for orchifunicolectomy was observed.

Introduction

The spread of coronavirus disease 2019 (COVID-19) has profoundly affected the care provided to patients diagnosed with cancer, with delays in diagnosis and treatment due to overwhelmed hospitals and a

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reallocation of medical resources [1–3]. Uro-oncological consultations and surgeries have also reportedly undergone a dramatic reduction, raising concerns about the risk of adverse oncologic outcomes related to delayed diagnosis and/or treatment [1, 4, 5]. For example, one study highlighted a significant reduction in prostate cancer (PCa) diagnosis in England [2, 6]. Timely diagnosis of cancer is crucial to optimize patients' clinical outcomes and has been considered to improve in recent decades. Therapeutic delays may lead to adverse oncological outcomes and patients with higher cancer stages [7]. However, to date, a comprehensive assessment of the COVID-19 pandemic's impact on the entire treatment pathway for genitourinary cancer care in Germany has not been carried out [2].

The aim of this study was to evaluate if the COVID-19 pandemic has actually led to more advanced disease features in urological cancers, including PCa, muscle-invasive bladder cancer (BCa), renal cancer, upper tract urothelial carcinoma (UTUC), testicular cancer, and penile cancer at a university medical center. We compared the characteristics and population of urological inpatients pre-, during, and after the COVID-19 pandemic.

Patients and Methods

Institutional Review Board approval was obtained before the initiation of the study. This study included a total of 907 patients treated for confirmed urologic cancer between January 2018 and February 2023 at a single university medical center (Department of Urology, University Medical Center Rostock) [2]. We identified all patients newly diagnosed with PCa in our institution according to the Clinical Cancer Registry (CCR) using the C61 code of 10th revision of the International Classification of Disease (ICD-10). The C67 code was used for BCa, C64 for renal cancer, and C65 to identify UTUC. Additionally, testicular cancer was identified using the C62 code, and C60 was used for penile cancer. The CCR also provided information on age at diagnosis and tumor stage (TNM classification). The OPS Classification of Interventions and Procedures version 2023, an administrative dataset encompassing all episodes in German hospitals, was used to determine specific procedures. The 5-60 code was used to identify patients who had a radical prostatectomy (RP), the 5-576 code for radical cystectomy (RC), the 5-554 code for radical nephrectomy (RN), the 5-553 code for partial nephrectomy (PN), and the 5-622 code was used to identify men undergoing orchifunicolectomy [2]. Age at diagnosis, preoperative prostate-specific antigen level, histopathological data (pathological T-stage, International Society of Urological Pathology [ISUP] grade group, lymph node involvement, metastatic status), chemotherapy, radiotherapy, body mass index (BMI), length of hospital stay (LOS), death, recurrence, and tumor size were recorded and evaluated. Patients with incomplete data were excluded.

Statistical Analysis

We analyzed the cohort based on the COVID-19 pandemic, including patients with new diagnoses of PCa, BCa, renal cancer, UTUC, testicular, or penile cancer in our institution between January 2018 and February 2023. Patients were considered to be part of the pre-COVID-19 pandemic subgroup if the date of their treatment was between January 1, 2018, and February 29, 2020. Additionally, patients were assigned to the COVID-19 pandemic subgroup if the treatment date fell between March 1, 2020, and March 31, 2022, and to the post-COVID-19 pandemic subgroup if the date was between April 1, 2022, and February 28, 2023. The data were analyzed using SPSS (Version 27, IBM Corp., Armonk, NY, USA). Categorical variables were presented as absolute numbers and proportions, while continuous variables were expressed as medians with interquartile ranges (IQR) or means with standard deviation (SD) when appropriate. Comparisons of categorical variables between the cohorts were made using Pearsons's χ^2 and Fisher's exact test, and specified according to the smallest theoretical frequency with Fisher's exact test used in case <5 and Pearson's χ^2 test >5. Continuous variables were compared using the independent samples t test for normally distributed data, and the Mann-Whitney U test was applied to non-normally distributed data. A p value of $p < 0.05$ was considered statistically significant.

Results

Prostate Cancer

Overall, 212 patients received RP after histopathological assurance (shown in Table 1). Notably, a lower recurrence rate was observed between the pre-COVID-19 pandemic and COVID-19 pandemic

Table 1. Descriptive characteristics for the cohort of 212 patients treated with RP between January 2018 and February 2023

Variables	Pre-COVID	During COVID	Post-COVID	*p* value
Patients, *n* (%)	64 (30)	104 (49)	44 (21)	
Age at diagnosis, median (IQR), years	65 (62–72)	67 (63–71)	66 (61–72)	0.6[a,b]/0.9[c]
PSA, mean (SD), ng/mL	18.5 (28.4)	16.9 (27.7)	10.8 (10.1)	0.6[a,c]/0.2[b]
BMI, mean (IQR), kg/m^2	28.5 (26–32)	28.8 (25–31)	27.7 (24–30)	0.6[a,b]/0.4[c]
LOS, mean (SD), days	32.1 (40)	14.6 (21.7)	8.5 (4.8)	0.2[a,b]/0.07[c]
ISUP grade at RP, *n* (%)				0.7[a]/0.6[b]/0.1[c]
1	8 (12.5)	12 (11.5)	6 (13.6)	
2	21 (32.8)	44 (42.3)	23 (52.3)	
3	19 (29.7)	29 (27.9)	10 (22.7)	
4	5 (7.8)	4 (3.8)		
5	11 (17.2)	14 (13.5)	4 (9.1)	
Unknown		1 (0.9)	1 (2.3)	
Pathological tumor stage, *n* (%)				0.7[a,b]/0.3[c]
pT2a	4 (6.3)	4 (3.8)	3 (6.8)	
pT2b		2 (1.9)	1 (2.3)	
pT2c	21 (32.8)	30 (28.8)	18 (40.9)	
pT3		1 (1)	1 (2.3)	
pT3a	17 (26.6)	26 (33.7)	10 (22.7)	
pT3b	20 (31.3)	29 (27.9)	9 (20.5)	
pT4	2 (3.1)	1 (1)		
Unknown		1 (1)		
Nodal tumor stage, *n* (%)				0.6[a,b]/0.2[c]
N0	49 (76.6)	86 (82.7)	39 (88.6)	
N+	14 (21.9)	17 (16.3)	5 (11.4)	
NX	1 (1.6)	1 (1)		
Metastatic status, *n* (%)				0.9[a,b,c]
M1	1 (1.6)	2 (1.9)	1 (2.3)	
Unknown	6 (9.4)	5 (4.8)	6 (6.8)	
Radiotherapy, *n* (%)	18 (28.1)	20 (19.2)	5 (11.4)	0.9[a,b,c]
Recurrence, *n* (%)	12 (18.8)	6 (5.8)	0	**<0.01*[a]**/0.2[b]/**≤0.001*[c]**
Death, *n* (%)	9 (14.1)	10 (9.6)	0	0.4[a]/**<0.05*[b]**/**≤0.01*[c]**

BMI, body mass index; PSA, prostate-specific antigen; ISUP, International Society of Urological Pathology. *Statistically significant difference. [a]Pre-COVID versus during COVID. [b]During COVID versus post-COVID. [c]Pre-COVID versus post-COVID.

subgroups (12% vs. 6%, $p < 0.01$), as well as between the pre-COVID-19 pandemic and post-COVID-19 pandemic subgroups (18.8% vs. 0%, $p \leq 0.001$). In addition, a higher death rate was reported in the COVID-19 pandemic subgroup compared to the post-COVID-19 pandemic subgroup (9.6% vs. 0%, $p < 0.05$), as well as between the pre-COVID-19 and post-COVID-19 subgroups (14% vs. 0%, $p \leq 0.01$). However, no differences were found in terms of tumor stage, ISUP grade, prostate-specific antigen value, age at diagnosis, BMI, and lymph node involvement.

Bladder Cancer

Overall, 157 patients underwent RC after histopathological assurance. Sixty-one patients (54.4%) of all male patients with BCa ($n = 112$) (shown in Table 2) had a synchronous PCa (shown in Table 3). Notably, a higher recurrence rate was observed in the COVID-19 pandemic subgroup compared to the post-COVID-19 pandemic subgroup (18.6% vs. 3.3%, $p < 0.05$) as well as between the pre-COVID-19 and post-COVID-19 subgroups (26.5% vs. 3.3%, $p < 0.05$). In addition, a higher death rate was reported in the pre-COVID-19 pandemic subgroup compared to the post-COVID-19

Table 2. Descriptive characteristics for the cohort of 157 patients treated with RC between January 2018 and December 2022

Variables	Pre-COVID	During COVID	Post-COVID	*p* value
Patients, *n* (%)	68 (43)	59 (38)	30 (19)	
Age at diagnosis, median (IQR), years	72.5 (63–78)	71 (64–79)	71 (64–81)	0.6[a]/0.3[b]/0.5[c]
Gender, *n* (%)				0.7[a]/0.4[b]/0.2[c]
Female	22 (32.4)	17 (28.8)	6 (20)	
Male	46 (67.6)	42 (71.2)	24 (80)	
BMI, mean (IQR), kg/m^2	27 (23–29)	25.9 (22–29)	26.8 (24–30)	0.2[a]/0.3[b]/0.8[c]
LOS, mean (SD), days	23.5 (23.3)	25.3 (14.7)	24.5 (20.2)	0.1[a]/0.4[b]/0.5[c]
Pathological tumor stage, *n* (%)				0.9[a]/0.2[b]/0.1[c]
pT1			2 (6.7)	
pT2	14 (20.6)	11 (18.6)	4 (13.3)	
pT2a	2 (2.9)	3 (5.1)	3 (10)	
pT2b	9 (13.2)	8 (13.6)	4 (13.3)	
pT3	5 (7.4)	2 (3.4)	1 (3.3)	
pT3a			4 (13.3)	
pT3b	11 (16.2)	8 (13.6)	8 (26.7)	
pT4a	13 (19.1)	13 (22)	3 (10)	
pT4b	11 (16.2)	13 (22)		
Unknown	3 (4.4)	1 (1.7)	1 (3.3)	
Nodal tumor stage, *n* (%)				0.1[a,b]/0.09[c]
N0	48 (70.6)	43 (72.9)	16 (53.3)	
N1	5 (7.4)	9 (15.3)	4 (13.3)	
N2	15 (22.1)	6 (10.2)	8 (26.7)	
NX		1 (1.7)	2 (6.7)	
Metastatic status, *n* (%)				0.9[a,b,c]
M1	7 (10)	3 (5)	3 (10)	
Therapy, *n* (%)				0.6[a]/0.1[b]/0.2[c]
Chemotherapy	16 (23.5)	14 (23.7)	9 (30)	0.6[#a]/0.9[#b]/0.5[#c]
Adjuvant	21 (30.9)	18 (30.5)	8 (26.7)	
Neoadjuvant	1 (1.5)	2 (3.4)	1 (3.3)	
Radiotherapy	1 (1.5)			
Radiochemotherapy	6 (8.8)	6 (10.2)		
Recurrence, *n* (%)	18 (26.5)	11 (18.6)	1 (3.3)	0.7[a]/<**0.05*[b,c]**
Death, *n* (%)	38 (55.9)	30 (50.8)	10 (33.3)	0.6[a]/0.1[b]/<**0.05*[c]**
Concomitant Cis, *n* (%)	9 (13.2)	5 (8.5)	2 (6.7)	0.4[a]/0.9[b]/0.5[c]
Urinary diversion, *n* (%)				<**0.05*[a]**/<**0.01*[b]**/0.5[c]
Ureterocutaneostomy	2 (2.9)	6 (10.2)		
Ileum conduit	55 (80.9)	49 (83.1)	23 (76.7)	
Ileal neobladder	11 (16.2)	2 (3.4)	7 (23.3)	
Unknown		2 (3.4)		

BMI, body mass index; Cis, carcinoma in situ. *Statistically significant difference. [a]Pre-COVID versus during COVID. [b]During COVID versus post-COVID. [c]Pre-COVID versus post-COVID. [#]Adjuvant versus neoadjuvant.

pandemic subgroup (55.9% vs. 33.3%, $p < 0.05$). A significant difference was also shown in urinary diversion between the pre-COVID-19 and COVID-19 subgroups ($p < 0.05$), as well as between the COVID-19 and post-COVID-19 subgroups ($p < 0.01$). However, no differences in terms of tumor stage, gender distribution, LOS, age at diagnosis, BMI, metastatic status, or further therapeutic treatments were found.

Table 3. Descriptive characteristics for the cohort of 61 patients treated with radical cystoprostatectomy with synchronous PCa (54%) between January 2018 and December 2022

Variables	Pre-COVID	During COVID	Post-COVID	*p* value
Patients, *n* (%)	20 (33)	28 (46)	13 (21)	
Age at diagnosis, median (IQR), years	75 (64–78)	72 (65–79)	66 (59–79)	0.6[a,b]/0.3[c]
BMI, mean (IQR), kg/m^2	27.6 (24–30)	29 (25–33)	26.9 (24–30)	0.3[a]/0.2[b]/0.7[c]
LOS, mean (SD), days	26.3 (23)	24.6 (19)	20.8 (7, 6)	0.9[a]/0.5[b]/0.4[c]
ISUP grade at RP, *n* (%)				0.3[a,b,c]
1	17 (85)	18 (64.3)	10 (76.9)	
2	3 (15)	6 (21.4)	1 (7.7)	
3		1 (3.6)	1 (7.7)	
4			1 (7.7)	
5				
Unknown		3 (10.7)		
Pathological tumor stage, *n* (%)				0.2[a]/0.6[b]/0.08[c]
pT2a	12 (60)	8 (28.6)	2 (15.4)	
pT2b				
pT2c	7 (35)	11 (39.3)	7 (53.8)	
pT3				
pT3a	1 (5)	3 (10.7)	2 (15.4)	
pT3b		2 (7.1)		
pT4		1 (3.6)		
Nodal tumor stage, *n* (%)				0.5[a]/0.9[b,c]
N0	20 (100)	26 (92.9)	13 (100)	
N+		2 (7.1)		
Death, *n* (%)	9 (45)	15 (53.6)	3 (23.1)	0.9[a,b,c]

BMI, body mass index. [a]Pre-COVID versus during COVID. [b]During COVID versus post-COVID. [c]Pre-COVID versus post-COVID.

Upper Tract Urothelial Carcinoma

Overall, 36 patients underwent nephroureterectomy for UTUC (shown in Table 4). Of these, 11 patients (30.6%) were treated before the COVID-19 pandemic, 20 patients (55.6%) during and 5 patients (14%) after the COVID-19 pandemic. No differences in terms of pathological features, age at diagnosis, tumor size and site, BMI, and LOS were reported.

Renal Cancer

Overall, 293 patients were diagnosed with renal cancer. In particular, 160 patients (54.6%) underwent RN (shown in Table 5), and 133 patients (45.4%) underwent PN (shown in Table 6). Notably, a significantly higher death rate was found for RN between the pre-COVID-19 pandemic and the COVID-19 pandemic subgroups (42.5% vs. 17.2%, $p < 0.01$) as well as between the pre-COVID-19 pandemic and post-COVID-19 pandemic subgroups (42.5% vs. 0%, $p < 0.001$). In addition, a significant difference in pathological tumor stage was observed between the pre-COVID-19 pandemic subgroup and the post-COVID-19 pandemic subgroup ($p < 0.05$). No further differences in terms of pathological features or other baseline characteristics were found. For patients who underwent PN, a higher tumor size was found in the pre-COVID-19 pandemic subgroup compared to the post-COVID-19 pandemic subgroup (3.8 cm vs. 2.6 cm, $p < 0.05$). In addition, also a higher death rate was observed between the pre-COVID-19 pandemic and COVID-19 pandemic subgroups (25.4% vs. 8.9%, $p < 0.05$), as well as between the pre-COVID-19 and post-COVID-19 subgroups (25.4% vs. 0%, $p < 0.01$). A significant difference in histology was also shown between the pre-COVID-19 and COVID-19 subgroups ($p < 0.05$).

Testicular Cancer

Overall, 93 patients underwent orchifunicolectomy for testicular cancer (shown in Table 7). Among these, 44 (47.3%) were treated before the COVID-19 pandemic, 42

Table 4. Descriptive characteristics for the cohort of 36 patients treated with nephroureterectomy between January 2018 and December 2022

Variables	Pre-COVID	During COVID	Post-COVID	*p* value
Patients, *n* (%)	11 (30.6)	20 (55.6)	5 (14)	
Age at diagnosis, median (IQR), years	75 (62–81)	77.5 (66–81)	70 (58–78)	0.5[a,c]/0.2[b]
Gender, *n* (%)				0.5[a]/0.6[b]/0.9[c]
Female	6 (54.5)	8 (40)	3 (60)	
Male	5 (45.5)	12 (60)	2 (40)	
BMI, mean (IQR), kg/m^2	27.6 (22–32)	25.2 (21–30)	23.8 (19–30)	0.3[a,c]/0.6[b]
LOS, mean (SD), days	10.9 (7.3)	12.4 (9.3)	11.2 (5.3)	0.5[a]/0.8[b]/0.9[c]
Pathological tumor stage, *n* (%)				0.5[a,b]/0.06[c]
pT1	2 (18.2)	3 (15)		
pT2		1 (5)		
pT3	9 (81.8)	13 (65)	3 (60)	
pT4		3 (15)	2 (40)	
Nodal tumor stage, *n* (%)				0.9[a]/0.6[b]/0.8[c]
N0	8 (72.7)	14 (70)	4 (80)	
N1	1 (9.1)	3 (15)		
N2	2 (18.2)	3 (15)	1 (20)	
Recurrence, *n* (%)	2 (18.2)	1 (5)	0	0.3[a]/0.9[b,c]
Death, *n* (%)	7 (63.6)	8 (40)	1 (20)	0.2[a]/0.6[b]/0.3[c]
Tumor site, *n* (%)				0.3[a]/0.5[b]/0.1[c]
Right	3 (27.3)	10 (50)	4 (80)	
Left	8 (72.7)	9 (45)	1 (20)	
Bilateral		1 (5)		

BMI, body mass index. [a]Pre-COVID versus during COVID. [b]During COVID versus post-COVID. [c]Pre-COVID versus post-COVID.

patients (45.2%) during, and 7 patients (7.5%) after the COVID-19 pandemic. A significantly higher LOS was found between the pre-COVID-19 pandemic and the COVID-19 pandemic subgroups (2.9 days vs. 2.3 days, $p < 0.05$). No differences were reported in terms of pathological features, age at diagnosis, tumor size, and BMI.

Penile Cancer

Overall, 39 patients were treated with penectomy and/or circumcision for penile cancer (shown in Table 8). Notably, a shift toward a higher age at diagnosis was observed between the pre-COVID-19 pandemic and COVID-19 pandemic subgroups (63 years vs. 70 years; $p < 0.05$). Furthermore, a shift toward higher death rate was found between the pre-COVID-19 pandemic and COVID-19 pandemic subgroups (15.4% vs. 57.1%, $p < 0.05$). No further differences in terms of pathological features or other baseline characteristics were found.

Discussion

In this study, comparisons were made among patients who presented with PCa, BCa, UTUC, renal, testicular, and penile cancer at our hospital either before, during, or after the COVID-19 pandemic. As the COVID-19 crisis prolonged, recommendations have been published to guide urologists in the management of urological conditions. Depending on the resources and capacity, surgical treatment was recommended only for high-priority and emergency cases during COVID-19 pandemic [8–10]. At the beginning of the pandemic, particularly from March to May 2020, only emergencies and urgent operations were prioritized in our center (e.g., testicular cancer or BCa), with the number of cases operated on during and after the pandemic remaining as stable as before. Surgery was reported to be harmful in asymptomatic patients who subsequently tested positive for COVID-19, while older patients with comorbidity and cancer

Table 5. Descriptive characteristics for the cohort of 160 patients treated with radical nephrectomy between January 2018 and December 2023

Variables	Pre-COVID	During COVID	Post-COVID	*p* value
Patients, *n* (%)	80 (50)	58 (36)	22 (14)	
Age at diagnosis, median (IQR), years	67 (60–76)	68 (60–77)	68 (61–78)	0.8[a,b]/0.7[c]
Gender, *n* (%)				0.6[a]/0.8[b]/0.5[c]
Female	27 (33.8)	22 (38)	9 (41)	
Male	53 (66.3)	36 (62)	13 (59)	
BMI, mean (IQR), kg/m^2	29.3 (25–33)	28.3 (24–30)	28.5 (26–31)	0.3[a]/0.9[b]/0.5[c]
LOS, mean (SD), days	7.5 (4.3)	8.1 (5.2)	7.8 (5.3)	0.4[a,c]/0.1[b]
Histology, *n* (%)				0.2[a]/0.4[b,c]
Clear cell RCC	60 (75.1)	48 (82.7)	16 (72.7)	
Papillary RCC	5 (6.3)	6 (10.3)	4 (18.2)	
Chromophobe RCC	5 (6.3)	2 (3.4)	1 (4.5)	
Sarcoamtoid RCC	2 (2.5)			
Others	8 (10)	1 (1.7)	1 (4.5)	
Unknown		1 (1.7)		
Pathological tumor stage, *n* (%)				0.2[a]/0.8[b]/<**0.05**[*c]
pT1a	10 (12.5)	5 (8.6)	1 (4.5)	
pT1b	4 (5)	9 (15.5)	5 (22.7)	
pT2a	4 (5)	6 (10.3)	2 (9.1)	
pT2b		2 (3.4)	1 (4.5)	
pT3a	53 (66.3)	29 (50)	12 (54.5)	
pT3b	6 (7.5)	5 (8.6)		
pT3c	1 (1.3)	1 (1.7)	1 (4.5)	
Unknown	2 (2.5)	1 (1.7)		
Nodal tumor stage, *n* (%)				0.5[a]/0.4[b]/0.1[c]
N0	62 (77.5)	49 (84.5)	21 (95.5)	
N1	10 (12.5)	6 (10.3)	1 (4.5)	
NX	8 (10)	3 (5.2)		
Metastatic status, *n* (%)			1 (4.5)	0.9[a,b,c]
M1	6 (7.5)	2 (3.4)		
Unknown	2 (2.5)	1 (1.7)		
Recurrence, *n* (%)	12 (15)	9 (15.5)	1 (4.5)	0.9[a]/0.3[b,c]
Death, *n* (%)	34 (42.5)	10 (17.2)	0	<**0.01**[*a]/0.05[b]/<**0.001**[*c]
Tumor site, *n* (%)				0.9[a,b,c]
Right	42 (52.5)	31 (53.4)	12 (54.5)	
Left	38 (47.5)	27 (46.6)	10 (45.5)	
Tumor size, mean (SD), cm	6.8 (3.2)	7.4 (3.7)	6.3 (2.9)	0.3[a]/0.2[b]/0.5[c]

BMI, body mass index; RCC, renal cell carcinoma. *Statistically significant difference. [a]Pre-COVID versus during COVID. [b]During COVID versus post-COVID. [c]Pre-COVID versus post-COVID.

were found to be at higher risk of COVID-19 infection, severe manifestation of the disease, and fatal outcome [1, 11, 12]. Most elective uro-oncologic procedures were found to be safely postponed, or even changed to another treatment modality, given a limited availability of healthcare resources. The primary concern in delaying uro-oncological surgeries is the risk of cancer progression and the potential significant backlog of patients in need of cancer care, given the high incidence of these neoplasms [13–16]. As demonstrated in a previous study, the cumulative delay in consultations and surgeries could have a ripple effect on future patients, further exacerbating potential adverse outcomes. The risk of cancer progression obviously varies

Table 6. Descriptive characteristics for the cohort of 133 patients treated with partial nephrectomy between January 2018 and December 2023

Variables	Pre-COVID	During COVID	Post-COVID	*p* value
Patients, *n* (%)	67 (50)	45 (34)	21 (16)	
Age at diagnosis, median (IQR), years	67.5 (62–77)	71.5 (59–79)	68.5 (64–75)	0.5[a]/0.8[b]/0.6[c]
Gender, *n* (%)				0.2[a,b]/0.6[c]
Female	25 (37.3)	12 (26.7)	9 (42.9)	
Male	42 (62.7)	33 (73.3)	12 (57.1)	
BMI, mean (IQR), kg/m^2	29.3 (26–31)	28.4 (25–32)	26.2 (23–31)	0.6[a]/0.1[b]/0.08[c]
LOS, mean (SD), days	6.8 (2.8)	7.2 (3.3)	6.3 (1.7)	0.4[a,c]/0.1[b]
Histology, *n* (%)				<**0.05*[a]**/0.5[b,c]
Clear cell RCC	50 (74.6)	29 (64.4)	13 (61.9)	
Papillary RCC	10 (14.9)	10 (22.2)	7 (33.3)	
Chromophobe RCC	4 (6)	3 (6.7)	1 (4.8)	
Sarcoamtoid RCC	1 (1.5)			
Others	1 (1.5)	3 (6.7)		
Unknown	1 (1.5)			
Pathological tumor stage, *n* (%)				0.3[a,b,c]
pT1a	34 (50.8)	30 (66.7)	14 (66.7)	
pT1b	16 (23.9)	7 (15.6)	1 (4.8)	
pT2a	1 (1.5)		1 (4.8)	
pT3a	12 (17.9)	4 (8.9)	4 (19)	
pT4	1 (1.5)	1 (2.2)		
Unknown	3 (4.5)	3 (6.7)	1 (4.8)	
Nodal tumor stage, *n* (%)				0.3[a,b]/0.7[c]
N0	60 (89.6)	37 (82.2)	20 (95.2)	
N1		1 (2.2)		
NX	7 (10.4)	7 (15.6)	1 (4.8)	
Recurrence, *n* (%)	8 (11.9)	3 (6.7)	0	0.5[a,b]/0.2[c]
Death, *n* (%)	17 (25.4)	4 (8.9)	0	<**0.05*[a]**/0.3[b]/<**0.01*[c]**
Tumor site, *n* (%)				0.4[a,c]/0.1[b]
Right	30 (44.8)	24 (53.3)	7 (33.3)	
Left	37 (55.2)	21 (46.7)	14 (66.7)	
Tumor size, mean (SD), cm	3.8 (2.4)	3 (1.3)	2.6 (1.4)	0.2[a,b]/<**0.05*[c]**

BMI, body mass index; RCC, renal cell carcinoma. *Statistically significant difference. [a]Pre-COVID versus during COVID. [b]During COVID versus post-COVID. [c]Pre-COVID versus post-COVID.

according to the type and grade of cancer. In a further study, the treatment of most patients with intermediate- and high-risk PCa could be deferred by 3–6 months without significant change in outcomes [1, 17]. The risk of progression is seen for muscle-invasive BCa with RC delays beyond 12 weeks from diagnosis or completion of neoadjuvant chemotherapy. For patients with high-grade UTUC, delays of 12 weeks in radical nephroureterectomy do not seem to be associated with adverse survival outcomes. As for renal tumors, surgery may be safely deferred for T1/T2 renal masses, while locally advanced tumors should be treated expeditiously [1, 8]. Following the recommendations of the European Association of Urology (EAU), priority was given to RC, within 30 days from the indication or the completion of neoadjuvant chemotherapy. Locally advanced renal tumors, high-risk PCa, and a high-grade UTUC were also expeditiously treated. While respecting the priority for the treatment of high-risk cancers; however, we continued to treat all urological neoplasms, as a university medical center [1, 8]. Surgical delay should be avoided

Table 7. Descriptive characteristics for the cohort of 93 patients treated with orchifunicolectomy between January 2018 and December 2022

Variables	Pre-COVID	During COVID	Post-COVID	*p* value
Patients, *n* (%)	44 (47.3)	42 (45.2)	7 (7.5)	
Age at diagnosis, median (IQR), years	34 (30–45)	37 (31–46)	40 (24–59)	0.4[a]/0.5[b]/0.3[c]
BMI, mean (IQR), kg/m^2	26.9 (23–30)	26 (23–29)	26.3 (22–30)	0.4[a]/0.9[b]/0.8[c]
LOS, mean (SD), days	2.9 (3.7)	2.3 (4)	1 (0)	<**0.05*[a]**/0.06[b]/0.2[c]
Histology, *n* (%)				0.4[a]/0.6[b]/0.1[c]
Seminoma	31 (70.5)	23 (54.8)	5 (71.4)	
Embryonal carcinoma	10 (22.7)	10 (23.8)	2 (28.6)	
Teratoma	3 (6.8)	5 (11.9)		
Choriocarcinoma		1 (2.4)		
Yolk sac tumor		1 (2.4)		
Others		2 (4.8)		
Pathological tumor stage, *n* (%)				0.5[a]/0.4[b]/0.3[c]
pT1	25 (56.8)	22 (52.4)	6 (85.7)	
pT2	12 (27.3)	15 (35.7)	1 (14.3)	
pT3	7 (15.9)	4 (9.5)		
Unknown		1 (2.4)		
Nodal tumor stage, *n* (%)				0.8[a]/0.6[b]/0.7[c]
N0	32 (72.7)	30 (71.4)	6 (85.7)	
N1	3 (6.8)	2 (4.8)		
N2	3 (6.8)	2 (4.8)		
N3	3 (6.8)	2 (4.8)	1 (14.3)	
NX	3 (6.8)	6 (14.3)		
Tumor size, mean (SD), cm	3.5 [2]	3.9 (2.1)	4.1 (4.7)	0.4[a]/0.9[b]/0.6[c]
Recurrence, *n* (%)	3 (6.8)	2 (4.8)	1 (1.4)	0.9[a]/0.4[b]/0.5[c]
Death, *n* (%)	2 (4.5)	2 (4.8)	0	0.9[a,b,c]
Tumor site				0.9[a,b,c]
Right	23 (52.3)	22 (52.4)	4 (57.1)	
Left	21 (47.7)	20 (47.6)	3 (42.9)	

BMI, body mass index. *Statistically significant difference. [a]Pre-COVID versus during COVID. [b]During COVID versus post-COVID. [c]Pre-COVID versus post-COVID.

when testicular cancer is suspected, also considering that orchifunicolectomy is typically performed in day hospitals and presents a minimal burden on the healthcare system [1, 18, 19].

The most interesting results of the present study are the pathologic data from our procedures: we had hypothesized a shift toward more advanced disease features, especially during the COVID-19 pandemic and post-COVID-19 subgroups, as a consequence of late diagnoses. Nevertheless, no significant differences in terms of main pathologic features were observed in patients who underwent RP, radical nephroureterectomy, RN, PN, orchifunicolectomy, and penectomy and/or circumcision, probably because of the lack of surgical delay [1]. A shift toward a higher death rate for penile cancer in the COVID-19 pandemic subgroup was observed as well as a higher age at diagnosis for penile cancer during the COVID-19 pandemic, due to healthcare system overburdening, pandemic fears and psychological causes, public reluctance, social isolation, and quarantine [7]. We also observed a decrease in LOS for testicular cancer between the pre-COVID-19 pandemic and COVID-19 pandemic subgroups. The shortening of the LOS reflects the COVID-19 regulations and economical aspects. The significant difference for recurrence and death rate for PCa, BCa, RN, and PN between the pre-COVID-19 pandemic and post-COVID-19 pandemic subgroups is due to the lack

Table 8. Descriptive characteristics for the cohort of 39 patients treated with penectomy and/or circumcision between January 2018 and December 2022

Variables	Pre-COVID	During COVID	Post-COVID	*p* value
Patients, *n* (%)	26 (67)	7 (18)	6 (15)	
Age at diagnosis, median (IQR), years	63 (55–73)	78 (72–86)	70 (63–79)	<**0.05***[a]/0.1[b]/0.3[c]
BMI, mean (IQR)	28.8 (28–32)	32 (26–37)	28.2 (26–31)	0.2[a]/0.3[b]/0.7[c]
Histology, *n* (%)				0.8[a,c]/0.9[b]
Squamous cell carcinoma	24 (92.3)	7 (100)	6 (100)	
Others	1 (3.8)			
Unknown	1 (3.8)			
Pathological tumor stage, *n* (%)				0.6[a]/0.5[b]/0.9[c]
pT1a	8 (30.8)	1 (14.3)	2 (33.3)	
pT1b	2 (7.7)	2 (28.6)	0	
pT2	12 (46.2)	3 (42.9)	3 (50)	
pT3	2 (2.2)	1 (14.3)	1 (16.7)	
pT4b	1 (3.8)			
Unknown	1 (3.8)			
Nodal tumor stage, *n* (%)				0.3[a]/0.6[b]/0.2[c]
N0	21 (80.8)	4 (57.1)	5 (83.3)	
N1	2 (7.7)	1 (14.3)		
N2	1 (3.8)			
N3		1 (14.3)		
NX	2 (7.7)	1 (14.3)	1 (16.7)	
Recurrence, *n* (%)	6 (23.1)	1 (14.3)	1 (16.7)	0.6[a,c]/0.9[b]
Death, *n* (%)	4 (15.4)	4 (57.1)	1 (16.7)	<**0.05***[a]/0.3[b]/0.9[c]
Concomitant Cis, *n* (%)	8 (30.8)	0	0	0.2[a]/0.9[b]/0.3[c]

BMI, body mass index; Cis, carcinoma in situ. *Statistically significant difference. [a]Pre-COVID versus during COVID. [b]During COVID versus post-COVID. [c]Pre-COVID versus post-COVID.

of long-term investigations (cancer progression or relapse), especially for the post-COVID-19 pandemic subgroup. Further, the tumor size decreased over time for PN, which was significant between the pre-COVID-19 pandemic and post-COVID-19 pandemic subgroups. Interestingly, during the pandemic, efforts were made to perform urinary diversions with ureterocutaneostomies or ileal conduits (and fewer neobladders) to minimize complications and LOS, while also accounting for the advanced stage of the disease.

Testicular cancer must be promptly treated at all times and minimally impacts the healthcare system as orchifunicolectomy is a quick procedure that requires a 1-day hospitalization [1]. In line with these considerations, avoiding surgical delay and a minimal burden on the healthcare system, in our center, we did not observe any differences in terms of pathological features.

Nevertheless, these results show that our institution, considering certain cancer entities (e.g., testicular cancer), generally took the right measures for urological patients during this time. However, a certain delay and/or an unclear cause for the higher nodal tumor stage in RC in the post-COVID-19 pandemic cohort can be assumed. This study is limited by its retrospective nature and single-center experience, which may limit the generalizability of pathologic and referral trends. Another limitation is the absence of long-term investigations.

Conclusion

However, we provided results of all major urologic oncological surgeries in a high-volume university medical center. Noteworthy is the absence of substantial delay in the treatment of uro-oncological diseases at our institution during and after the COVID-19 pandemic. Importantly, no significant worsening of cancer disease

features was found. However, the risk of submerged disease and late diagnoses cannot be ruled out and might become apparent in a longer time span.

Statement of Ethics

This study protocol was reviewed and approved by the Ethics Committee of the University Medical Center Rostock (approval No. A 2023-0174). The need for informed consent was waived by the Ethics Committee of the University Medical Center Rostock.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

M.E.: project development, data analysis, and manuscript writing. H.Z.: data collection. D.L.D.: data generating. O.W.H.: manuscript editing.

Data Availability Statement

The data that support the findings of this study are not publicly available due to privacy restrictions but are available from the corresponding author M.E. upon reasonable request.

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