

STOLAREK, Kacper, KOWALCZYK, Emilia, SZAREK, Mateusz, ANDRZEJAK, Alicja, OLSZEWSKI, Hubert. Hydronephrosis Associated with Cervical Cancer: Case Report on Pathophysiology, Diagnosis, and Management. *Quality in Sport*. 2024;26:55041. eISSN 2450-3118.

<https://dx.doi.org/10.12775/QS.2024.26.55041>

<https://apcz.umk.pl/OS/article/view/55041>

The journal has been 20 points in the Ministry of Higher Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Higher Education and Science of 05.01.2024. No. 32553.

Has a Journal's Unique Identifier: 201398. Scientific disciplines assigned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).

Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 r. Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398.

Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

© The Authors 2024;

This article is published with open access at Licensee Open Journal Systems of Nicolaus Copernicus University in Torun, Poland Open Access. This article is distributed under the terms of the Creative Commons Attribution Noncommercial License which permits any noncommercial use, distribution, and reproduction in any medium, provided the original author (s) and source are credited. This is an open access article licensed under the terms of the Creative Commons Attribution Non commercial license Share alike. (<http://creativecommons.org/licenses/by-nc-sa/4.0/>) which permits unrestricted, non commercial use, distribution and reproduction in any medium, provided the work is properly cited.

The authors declare that there is no conflict of interests regarding the publication of this paper.

Received: 09.09.2024. Revised: 27.09.2024. Accepted: 7.10.2024. Published: 17.10.2024.

Hydronephrosis Associated with Cervical Cancer: Case Report on Pathophysiology, Diagnosis, and Management

Kacper Stolarek

SPZZOZ w Kozienicach

kacper1103@gmail.com

<https://orcid.org/0000-0002-4333-7215>

Emilia Kowalczyk

Uniwersytet Medyczny w Lublinie

emilia.kowalczyk99@gmail.com

<https://orcid.org/0000-0001-7687-8870>

Mateusz Szarek

Provincial Specialist Hospital in Wrocław

szary_222@wp.pl

<https://orcid.org/0000-0003-0678-7599>

Alicja Andrzejak

ZOZ w Brodnicy im. R. Czerwiakowskiego

a.andrzejak@me.com

<https://orcid.org/0000-0002-4720-6861>

Hubert Olszewski

ZOZ w Brodnicy im. R. Czerwiakowskiego

hubert.olszewski98@gmail.com

<https://orcid.org/0000-0002-6019-6047>

Corresponding author: Kacper Stolarek, kacper1103@gmail.com

ABSTRACT

Introduction and Purpose

Cervical cancer is one of the most common malignancies in women, accounting for the fourth most common cancer worldwide and the sixth in Poland. Despite advances in diagnosis and prevention, the condition is still associated with a high mortality rate, especially in advanced stages. One of the significant complications of advanced cervical cancer is hydronephrosis, occurring in about 23% of patients. Hydronephrosis develops as a result of blocked urine outflow, which leads to stretching of the renal calyces and can result in renal failure if not properly treated. Management strategies for hydronephrosis include ureteral stenting and percutaneous nephrostomy, both of which are effective in draining the kidneys and improving patient outcomes.

Aim of the study

This article discusses the pathophysiology, diagnosis and treatment of hydronephrosis in patients with cervical cancer, and presents a detailed case report of a patient with advanced cervical cancer complicated by hydronephrosis and renal perforation.

Results and Future directions

The patient was admitted to the urology department for bleeding into the retroperitoneal space after renal fistula replacement. During hospitalization, despite numerous complications, the patient's condition stabilized after blood and plasma transfusions, intensive antibiotic therapy and renal fistula re-implantation. The final results of the treatment were successful, and the patient was discharged with appropriate recommendations. The study highlights the importance of early diagnosis and effective treatment of hydronephrosis to improve the prognosis of patients with cervical cancer. It underscores the need for multidisciplinary collaboration involving urologists, oncologists and other specialists to provide comprehensive care tailored to the patient's evolving needs.

Keywords: cervical cancer; hydronephrosis; percutaneous nephrostomy; ureteral stenting

INTRODUCTION

Cervical cancer

Cervical cancer ranks among the most prevalent cancers affecting women, holding the position as the fourth most frequently diagnosed cancer in women globally [1,2]. About 7000000 new cases are identified annually, and of which more than half of patients die [3]. In 2020, 3,862 new cases of cervical cancer were reported in Poland. It is ranked 6th among female malignancies. The reported number of deaths was 2,137, making cervical cancer the 7th among female cancers in terms of mortality [4]. The problem most frequently affects women in the 3rd-5th decade of life. Very rarely it appears before the age of 20 [5]. Due to the limited availability of screening in underdeveloped countries, these are the areas where most cases of this cancer are reported. In developing countries, improvements in diagnostic methods like

liquid cytology and the spread of vaccines against oncogenic genotypes of the human papillomavirus (HPV) have made it possible to significantly reduce the number of new cases of the cancer as well as deaths caused by the disease. However, despite this, cervical cancer still ranks high in the structure of incidence and death [2,6].

The main risk factors for cervical cancer are age, infection with the oncogenic HPV genotype, early sexual initiation (<16 years of age), a large number of sexual partners, cigarette smoking, HIV infection, and low socioeconomic status [1,4]. The most common symptoms of cancer are longer and heavier periods, pain during sex, bleeding between periods and after sex, vaginal discharge, abdominal and low back pain [4,16]. Treatment depends on the stage and may include only resection of the cancerous lesions, but also radical hysterectomy or radio-chemotherapy for higher stages [1,17]. Invasive cervical cancer can infiltrate surrounding tissues, i.e. the bladder, ureter, rectum. It also spreads through lymphatic routes to lymph nodes and through the bloodstream developing distant metastases [5].

Hydronephrosis and other complications

Patients with advanced stage III to IVB cancer, experience many complications related to tumor infiltration and metastasis. One retrospective study by Khulpateea BR et al. estimated that the most common complications are fistulas (44%, 55% of which are complex bladder-vaginal fistulas), hydronephrosis, fistula diversion, and urinary tract infections [7]. Urological complications also occur after cervical cancer treatment. The main complications after radical hysterectomy include underactive bladder, overactive bladder displacer, urinary incontinence, fistula and hydronephrosis [8,20].

An important complication of cervical cancer invasion that has still not been sufficiently explored is hydronephrosis. One study that included 279 patients with cervical cancer showed that hydronephrosis occurs as a complication of the disease in 23% of women [9,18]. Hydronephrosis develops when a blockage in the renal collecting system leads to a distension of the renal calyces. Causes of ureteral obstruction can include obstruction of the flow of urine due to the tumor mass or metastatic lymph nodes pressure on the ureters and frequent urinary tract infections and scarring of the pelvic edges. Chronic obstruction can result in renal dysfunction and if left untreated, can progress to kidney failure [9,10]. According to Tan et al, the incidence is higher in patients with advanced stages of cervical cancer, particularly in stages III and IV. Risk factors include the size and location of the tumor, lymph node involvement,

and prior pelvic radiation therapy, which can cause fibrosis and scarring, further complicating the ureters [11,19].

Treatment of hydronephrosis

Since hydronephrosis is known to significantly reduce the prognosis of patients with cervical cancer, adequate drainage of the ureters is important. Ureteral stenting insertion is recommended, and when it is not possible as in patients undergoing radio- and chemotherapy, percutaneous nephrostomy is used [10,12,13]. A percutaneous nephrostomy, which involves inserting a catheter directly into the kidney to allow urine to bypass the obstruction, can provide an alternative route for urine drainage [11,21].

Percutaneous nephrostomy is a minimally invasive procedure used to drain urine directly from the kidney in cases of urinary tract obstruction [42]. The procedure involves inserting a small tube into the kidney under imaging guidance to drain urine into an external bag. It is used for conditions such as kidney stones, tumors, and infections [40]. The advantages of this procedure include immediate relief of kidney obstruction, preservation of kidney function, and being less invasive than surgery [45]. Aftercare involves monitoring for complications, managing the external drainage system, and regular follow-ups [41,46]. Potential risks include bleeding, infection, tube displacement, urine leakage, and damage to surrounding structures [42,43]. Overall, percutaneous nephrostomy is an effective and safe procedure for treating urinary obstruction and providing relief to patients [44]. The study conducted by Dhani FK. et al showed that when patients with bilateral or unilateral hydronephrosis were treated with ureteral stents or percutaneous nephrostomy, median survival was similar - 11.0 months for stents and 15.00 for nephrostomy, so both methods can be considered as effective and beneficial for patients experiencing this complication [14].

The JJ stent, also known as a double J stent or ureteral stent, is a popular and effective treatment for hydronephrosis, especially for urinary tract obstructions that prevent the proper flow of urine from the kidneys to the bladder [24,27]. The stent acts as a temporary support for the kidneys, relieving pressure on them, preventing damage and relieving symptoms while addressing the cause of the obstruction [28]. The role of the JJ stent in the treatment of hydronephrosis is to relieve urinary obstruction by placing a thin, flexible tube, such as the JJ stent, into the ureter that connects the kidney to the bladder. This stent makes it possible to bypass an obstruction or narrowing of the ureter [29]. By acting in this way, the stent keeps the channel open for urine flow, which helps reduce the back pressure in the kidney that results

from hydronephrosis. This happens by improving urine flow and preventing further damage to renal tissue and the risk of kidney failure. The JJ stent also serves the function of draining urine directly from the kidney into the bladder, even when the natural flow path is blocked or narrowed [28]. This is especially important in cases where the obstruction is due to kidney stones, tumors, stenosis or external compression. Thanks to the “double J” design with wraps at both ends, the stent is anchored in place in the kidney and bladder, preventing it from moving or slipping out of position [30]. The JJ stent acts as a temporary solution to relieve symptoms and prevent infection. It is often used as an interim step, pending definitive treatment. However, it should only be used under the supervision of a physician, as the wrong stent implantation site can lead to complications. Therefore, it is essential to control and regularly replace the stent at specified intervals. It is worth noting that the JJ stent is an effective and frequently used treatment for hydronephrosis [25]. It is a temporary solution that improves urine flow, prevents kidney damage and relieves symptoms. However, it is important to always consult a doctor to properly select therapy and monitor the progression of the disease [26].

AIM OF THE STUDY

This article explores the incidence, management, and prognosis of hydronephrosis in cervical cancer patients and presents a detailed case report of a patient with advanced cervical cancer complicated by hydronephrosis and subsequent kidney perforation.

CASE REPORT

The patient was admitted to the Department of Urology as an emergency due to bleeding into the retroperitoneal space after replacement of a left renal fistula. The patient was brought in by the Emergency Medical Team with symptoms of shock. Laboratory tests performed in the Hospital Emergency Department showed abnormal coagulation (PLT 50,000/ μ l) and low morphotic parameters (HGB 6.8 g/dL). The CT scan described: left-sided perinephric hematoma, correctly located right-sided nephrostomy, left-sided nephrostomy located abnormally draining the retroperitoneal space. The patient's medical history showed bilateral renal fistulas created due to hydronephrosis caused by cervical carcinoma. Laboratory tests at the time of fistula formation: creatinine 12 mg/dl, creatinine 0.6 mg/dl at follow-up in the ward.

The transfusion of 3 units of supplementary red blood cells (RBC) and 2 units of fresh

frozen plasma (FFP) transfusion was performed due to the low HGB level. The patient's general condition stabilized to normal blood pressure and pulse rate and proper logical contact. Diuresis from the right fistula reached 400 ml. In control laboratory tests performed on subsequent days of hospitalization: HGB 8.5 g/dL , creatinine 1.7 mg/dL. In the following days, there was a significant increase in inflammatory parameters - high doses of antibiotics were administered. In the following days, there was a gradual decrease in red blood cell parameters and normalization of inflammatory parameters. Due to increasing anemia, another 2 units of red blood cells (RBCs) were transfused - in the control morphology, the HGB level was 10.3 g/dL.

With the normalization of inflammatory and morphological parameters, a new renal fistula was created the following day and a drain was inserted to empty the hematoma. Since this procedure, the patient's well-being has improved significantly with no fever in the following days. The patient was scheduled to have a follow-up CT scan, which was abandoned due to high TSH values. An examination of Ft3 and Ft4 hormone levels was ordered, and an internal medicine consultation was recommended, with a recommendation for thyroid ultrasonography, follow-up hormone and TSH levels, and further endocrine diagnostics.

On the following day of hospitalization, the left drain of the incorrectly located nephrostomy was removed. In the following days, normalization of inflammatory and renal parameters was observed. A follow-up CT scan was performed, which showed significant reabsorption of the hematoma of the left renal region. In the following days, the hematoma drain was removed. On the day of discharge, complete normalization of renal and inflammatory parameters was observed. The patient was discharged from the Urology Department with normal bilateral nephrostomies without assurance drains. The patient was advised: further treatment of cervical cancer as planned at the oncology center and to report for renal fistula replacement in 6 weeks at the Urology Outpatient Clinic. Replacement of fistulas should take place under X-ray scopy control.

DISCUSSION

The case presented here highlights the need for a complex interaction between cervical cancer, hydronephrosis and subsequent urological complications, underscoring the need for prompt and appropriate treatment of these conditions [34]. Hydronephrosis, as in the presented patient, is a documented complication of advanced cervical cancer, often resulting from cancer-induced

ureteral obstruction or metastatic pelvic lymph node involvement, which can significantly worsen a patient's prognosis if not treated appropriately [32].

Treatment of hydronephrosis typically involves the insertion of ureteral stents or percutaneous nephrostomy to ensure proper urinary drainage, both of which have shown similar efficacy and safety [31]. However, it is not uncommon for complications of these interventions to occur, such as infection, bleeding, and perforation leading to retroperitoneal hemorrhage as in the described clinical case, and require close monitoring and prompt intervention to ensure that the patient's condition does not seriously deteriorate and lead to a life-threatening condition [34].

The patient's case shows the increased risk of vascular and organ damage during these procedures, as the patient is weight-bearing and debilitated due to advanced malignancy. Successful treatment of the bleeding and anemia, along with careful monitoring of renal function and inflammatory parameters, helped stabilize the patient's condition. Choosing the right time to create a new nephrostomy and drain the hematoma were key steps in treating the described acute complications and restoring renal function, as evidenced by the normalization of the patient's renal and inflammatory parameters [31].

This case also underscores the importance of a multidisciplinary approach involving urologists, oncologists and other specialists to properly treat and care for patients with cervical cancer and urological complications. Continuous evaluation of laboratory parameters and the patient's condition allows for early recognition of any disorders. Early noticing of endocrine changes and referral of the patient for endocrine diagnostics is essential to optimize treatment outcomes (source, source). The treatment of hydronephrosis in patients with cervical cancer remains a challenge and is still insufficiently understood and described in the literature, and is crucial for improving the quality of life of these patients. The case underscores the need for further research and improvement and standardization of treatment protocols [33,36].

Evolving novel interventional techniques, such as percutaneous image-guided procedures, are e.g. highlighting the importance of integrating advanced technologies to treat hydronephrosis in patients with carotid cancer [39]. Techniques such as real-time ultrasound or CT-guided nephrostomy have the potential to reduce the risk of vascular damage and improve procedure success rates, especially in patients with anatomically complex or disabling disease [36,38]. The implementation of such methods, along with standard practices, underscores the need for ongoing training and skill development among interventional radiologists and urologists to better meet the challenges of these complex cases [35,37].

Moreover, the need for a personalized approach is underscored by the heterogeneity of patient response to interventions, which is influenced by factors such as tumor burden, anatomic differences and the presence of comorbidities [32]. With further advances in the integration of genetic and molecular profiling in the treatment of cervical cancer, there is potential to identify patient-specific risk factors for urologic complications that could guide more targeted preventive measures or tailored intervention strategies. These advances, combined with robust multidisciplinary collaboration, could significantly improve patient outcomes and quality of life by minimizing procedural risks and optimizing overall management strategies [33].

FUTURE DIRECTIONS

The complexity of treating hydronephrosis in patients with cervical cancer, especially with regard to progression to serious complications such as renal perforation and renal failure, underscores the need for advanced diagnostic tools. The study highlights the potential of dynamic contrast-enhanced MRI and diffusion-weighted imaging to provide a more precise assessment of ureteral obstruction and renal function, which is consistent with the suggestion for improved diagnostic strategies [9,15].

Studies comparing the outcomes of different treatments, such as ureteral stents versus percutaneous nephrostomy, could help determine the most appropriate approach based on individual patient factors and cancer stage. The importance of personalized medicine, including genetic and molecular profiling, is increasingly recognized in tailoring therapy to minimize urologic complications [9].

It is worth focusing further research to investigate new biomarkers that could predict the risk of hydronephrosis and its complications in patients with cervical cancer, enabling earlier intervention. In addition, the current development of artificial intelligence and robotics methods could help prevent the complications of the methods described and detect ureteral obstruction early on imaging studies [22,23].

CONCLUSION

This case highlights the significant impact of hydronephrosis as a complication of advanced cervical cancer. The successful treatment of this patient through timely interventions, including the use of nephrostomy, underscores the importance of vigilant monitoring and prompt

treatment to improve outcomes. The normalization of renal and inflammatory parameters after interventions reflects the effectiveness of these procedures in treating acute complications.

However, the case also illustrates the challenges associated with such complex clinical scenarios, including the risk of procedural complications such as retroperitoneal bleeding. It underscores the need for multidisciplinary collaboration involving urologists, oncologists and other specialists to provide comprehensive care tailored to the patient's evolving needs.

In addition, this case highlights the importance of an individualized approach to treatment, taking into account the patient's overall health, cancer stage and specific complications. Regular observation and imaging are crucial for early detection of signs of obstruction or impaired renal function, allowing timely adjustment of treatment strategies. The ever-improving artificial intelligence and imaging techniques using it may show promise here. This case also highlights the role of advanced imaging techniques and minimally invasive interventions in improving patient care. Continuous improvements in diagnostic and therapeutic methods can significantly reduce morbidity and improve quality of life for patients suffering from cervical cancer and its complications.

DISCLOSURE

Author's contribution

Conceptualization: Kacper Stolarek, Emilia Kowalczyk, Mateusz Szarek, Alicja Andrzejak; methodology: Emilia Kowalczyk, Kacper Stolarek, Hubert Olszewski.; software: Hubert, olszewski, Mateusz Szarek, Kacper Stolarek, Emilia Kowalczyk; formal analysis: Alicja Andrzejak, Emilia Kowalczyk , Kacper Stolarek.; investigation: Emilia Kowalczyk, Mateusz Szarek, Kacper Stolarek, Hubert Olszewski; resources: Mateusz Szarek, Alicja Andrzejak, Emilia Kowalczyk, Kacper Stolarek; data curation: Kacper Stolarek, Hubert Olszewski, Emilia Kowalczyk, Mateusz Szarek; writing - rough preparation: Emilia Kowalczyk, Kacper Stolarek, Mateusz Szarek, Hubert Olszewski; writing - review and editing: Kacper Stolarek, Emilia Kowalczyk, Mateusz Szarek, Alicja Andrzejak; visualization: Emilia Kowalczyk, Kacper Stolarek, Mateusz Szarek, Hubert Olszewski; supervision: Kacper Stolarek, Emilia Kowalczyk, Mateusz Szarek, Alicja Andrzejak.; project administration: Kacper Stolarek, Emilia Kowalczyk, Mateusz Szarek.

All authors have read and agreed with the published version of the manuscript.

Funding Statement

This research received no external funding.

Institutional Review Board Statement

Not applicable

Informed Consent Statement

Not applicable

Data Availability Statement

Not applicable

Conflict of Interest Statement

The authors declare no conflict of interest.

REFERENCES

- [1] Johnson CA, James D, Marzan A, Armaos M. Cervical Cancer: An Overview of Pathophysiology and Management. *Semin Oncol Nurs.* 2019;35(2):166-174. doi:10.1016/j.soncn.2019.02.003
- [2] dr hab. n. med. Paweł Blecharz, Rak szyjki macicy: przyczyny, objawy, leczenie i szczepienie, Available from: <https://www.mp.pl/pacjent/onkologia/chorobynowotworowe/99295,rak-szyjki-macic>
- [3] Sahasrabuddhe VV. Cervical Cancer: Precursors and Prevention. *Hematol Oncol Clin North Am.* 2024;38(4):771-781. doi:10.1016/j.hoc.2024.03.005

- [4] Rak szyjki macicy Aktualizacja w 2021 roku, Available from:
https://www.onkonet.pl/dp_nnr_rakszyjkimacicy.php
- [5] Jan Zieliński, Rak szyjki macicy (r.sz.m.)/Cervical carcinoma, *Czytelnia Medyczna, Nowa Medycyna*, 5-6/2001, Available from:
<https://www.czytelniamedyczna.pl/3252,rak-szyjki-macicy-rszm.html>
- [6] Martínez-Rodríguez F, Limones-González JE, Mendoza-Almanza B, et al. Understanding Cervical Cancer through Proteomics. *Cells*. 2021;10(8):1854. Published 2021 Jul 22. doi:10.3390/cells10081854
- [7] Khulpateea BR, Paulson A, Carlson M, Miller DS, Lea J. Stage IVA cervical cancer: outcomes of disease related complications and treatment. *Int J Gynecol Cancer*. 2021;31(4):518-523. doi:10.1136/ijgc-2019-000386
- [8] Wit EM, Horenblas S. Urological complications after treatment of cervical cancer. *Nat Rev Urol*. 2014;11(2):110-117. doi:10.1038/nrurol.2013.323
- [9] Patel K, Foster NR, Kumar A, et al. Hydronephrosis in patients with cervical cancer: an assessment of morbidity and survival. *Support Care Cancer*. 2015;23(5):1303-1309. doi:10.1007/s00520-014-2482-y
- [10] Li J, Cao H, Peng K, Chen R, Sun X. Hydronephrosis in patients with cervical cancer: An improved stent-change therapy for ureteral obstruction Stent-change for ureteral obstruction in cervical cancer. *Eur J Obstet Gynecol Reprod Biol*. 2023;283:49-53. doi:10.1016/j.ejogrb.2023.01.026
- [11] Tan S, Tao Z, Bian X, et al. Ureteral stent placement and percutaneous nephrostomy in the management of hydronephrosis secondary to cervical cancer. *Eur J Obstet Gynecol Reprod Biol*. 2019;241:99-103. doi:10.1016/j.ejogrb.2019.08.020
- [12] Yang YR, Chen SJ, Yen PY, et al. Hydronephrosis in patients with cervical cancer is an indicator of poor outcome: A nationwide population-based retrospective cohort study. *Medicine (Baltimore)*. 2021;100(6):e24182. doi:10.1097/MD.00000000000024182
- [13] Warli SM, Tala MRZ, Wijaya WS. Predictive Factors of Successful Double J Stent Insertion Among Advanced Cervical Cancer Patients. *World J Oncol*. 2024;15(2):239-245. doi:10.14740/wjon1631
- [14] Dhani FK, Daryanto B, Seputra KP. Survival Outcome of Urinary Diversion in Advanced Cervical Cancer Patients with Hydronephrosis. *Asian Pac J Cancer Prev*. 2023;24(8):2641-2646. Published 2023 Aug 1. doi:10.31557/APJCP.2023.24.8.2641

- [15] Nóbrega L, Zanon JR, Andrade CEEMDC, Schmidt RL, Dos Santos MH, Dos Reis R. Prognostic role of hydronephrosis in the treatment of patients with locally advanced cervical cancer: a retrospective cohort. *Int J Gynecol Cancer*. Published online August 16, 2022. doi:10.1136/ijgc-2022-003679
- [16] Buskwofie A, David-West G, Clare CA. A Review of Cervical Cancer: Incidence and Disparities. *J Natl Med Assoc*. 2020;112(2):229-232. doi:10.1016/j.jnma.2020.03.002
- [17] Li H, Wu X, Cheng X. Advances in diagnosis and treatment of metastatic cervical cancer. *J Gynecol Oncol*. 2016;27(4):e43. doi:10.3802/jgo.2016.27.e43
- [18] Rose PG, Ali S, Whitney CW, Lanciano R, Stehman FB. Impact of hydronephrosis on outcome of stage IIIB cervical cancer patients with disease limited to the pelvis, treated with radiation and concurrent chemotherapy: a Gynecologic Oncology Group study. *Gynecol Oncol*. 2010;117(2):270-275. doi:10.1016/j.ygyno.2010.01.045
- [19] Chao KS, Leung WM, Grigsby PW, Mutch DG, Herzog T, Perez CA. The clinical implications of hydronephrosis and the level of ureteral obstruction in stage IIIB cervical cancer. *Int J Radiat Oncol Biol Phys*. 1998;40(5):1095-1100. doi:10.1016/s0360-3016(97)00899-7
- [20] Atuhairwe S, Busingye RB, Sekikubo M, Nakimuli A, Mutyaba T. Urologic complications among women with advanced cervical cancer at a tertiary referral hospital in Uganda. *Int J Gynaecol Obstet*. 2011;115(3):282-284. doi:10.1016/j.ijgo.2011.07.021
- [21] Shah M, Blest F, Blackmur J, Laird A, Dawson S, Aning J. Malignant upper urinary tract obstruction in cancer patients: A systematic review. *BJUI Compass*. 2024;5(5):405-416. Published 2024 Feb 27. doi:10.1002/bco2.340
- [22] Alexa R, Kranz J, Kramann R, et al. Harnessing Artificial Intelligence for Enhanced Renal Analysis: Automated Detection of Hydronephrosis and Precise Kidney Segmentation. *Eur Urol Open Sci*. 2024;62:19-25. Published 2024 Feb 22. doi:10.1016/j.euros.2024.01.017
- [23] Serel A, Ozturk SA, Soyupek S, Serel HB. Deep Learning in Urological Images Using Convolutional Neural Networks: An Artificial Intelligence Study. *Turk J Urol*. 2022;48(4):299-302. doi:10.5152/tud.2022.22030
- [24] National Guideline Centre (UK). *Timing of surgery: Renal and ureteric stones: assessment and management*. London: National Institute for Health and Care Excellence (NICE); January 2019.

- [25] National Guideline Centre (UK). *Stents before surgery: Renal and ureteric stones: assessment and management*. London: National Institute for Health and Care Excellence (NICE); January 2019.
- [26] National Guideline Centre (UK). *Stents after surgery: Renal and ureteric stones: assessment and management*. London: National Institute for Health and Care Excellence (NICE); January 2019.
- [27] Geavlete P, Georgescu D, Muțescu R, Stanescu F, Cozma C, Geavlete B. Ureteral stent complications - experience on 50,000 procedures. *J Med Life*. 2021;14(6):769-775. doi:10.25122/jml-2021-0352
- [28] Branger N, Lorusso V, Pacchetti A, et al. Impact of long-term indwelling JJ stent on renal volume and renal function. *Minerva Urol Nephrol*. 2023;75(6):752-760. doi:10.23736/S2724-6051.22.04975-8
- [29] Washida H, Tsugaya M, Hirao N, Sakagami H, Iwase Y. *Hinyokika Kyo*. 1986;32(3):413-421.
- [30] DE Lorenzis E, Zanetti SP, Boeri L, Albo G, Montanari E. Long-term ureteral JJ stent: useful, useless or harmful?. *Minerva Urol Nephrol*. 2023;75(6):667-671. doi:10.23736/S2724-6051.23.05541-6
- [31] Damian FB, de Almeida FK, Fernandes FS, Jimenez MF. Impact of hydronephrosis and kidney function on survival in newly diagnosed advanced cervical cancer. *Gynecol Oncol Rep*. 2022;39:100934. Published 2022 Jan 22. doi:10.1016/j.gore.2022.100934
- [32] Goklu MR, Seckin KD, Togrul C, et al. Effect of hydronephrosis on survival in advanced stage cervical cancer. *Asian Pac J Cancer Prev*. 2015;16(10):4219-4222. doi:10.7314/apjcp.2015.16.10.4219
- [33] Pergialiotis V, Bellos I, Thomakos N, et al. Survival outcomes of patients with cervical cancer and accompanying hydronephrosis: A systematic review of the literature. *Oncol Rev*. 2019;13(1):387. Published 2019 Jan 15. doi:10.4081/oncol.2019.387
- [34] Nakamura H, Ko K, Kiseki H, Ikeda SI. Renal Subcapsular Hematoma Formation Due to Hydronephrosis Caused by Recurrent Uterine Cervical Cancer. *J Med Cases*. 2021;12(3):126-129. doi:10.14740/jmc3640
- [35] Sowunmi AC, Ajekigbe AT, Alabi AO, Popoola AO, Fatiregun OA, Akinyanju AM. Incidence of Hydronephrosis in Cervical Cancer Patients in A Tertiary Hospital Lagos, Nigeria. *Nig Q J Hosp Med*. 2015;25(3):171-176.

- [36] Brandt MP, Lehnert T, Czilwik T, et al. CT-guided nephrostomy-An expedient tool for complex clinical scenarios. *Eur J Radiol*. 2019;110:142-147. doi:10.1016/j.ejrad.2018.11.028
- [37] Smith PE, Luong ITH, van der Vliet AH. CT-guided nephrostomy: Re-inventing the wheel for the occasional interventionalist. *J Med Imaging Radiat Oncol*. Published online March 12, 2018. doi:10.1111/1754-9485.12720
- [38] Thanos L, Mylona S, Stroumpouli E, Kalioras V, Pomoni M, Batakis N. Percutaneous CT-guided nephrostomy: a safe and quick alternative method in management of obstructive and nonobstructive uropathy. *J Endourol*. 2006;20(7):486-490. doi:10.1089/end.2006.20.486
- [39] Li F, Guo H, Qiu H, et al. Urological complications after radical hysterectomy with postoperative radiotherapy and radiotherapy alone for cervical cancer. *Medicine (Baltimore)*. 2018;97(13):e0173. doi:10.1097/MD.00000000000010173
- [40] Dyer RB, Regan JD, Kavanagh PV, Khatod EG, Chen MY, Zagoria RJ. Percutaneous nephrostomy with extensions of the technique: step by step. *Radiographics*. 2002;22(3):503-525. doi:10.1148/radiographics.22.3.g02ma19503
- [41] Zhang KP, Zhang Y, Chao M. Which is the best way for patients with ureteral obstruction? Percutaneous nephrostomy versus double J stenting. *Medicine (Baltimore)*. 2022;101(45):e31194. doi:10.1097/MD.00000000000031194
- [42] Cozma C, Georgescu D, Popescu R, Geavlete B, Geavlete P. Double-J stent versus percutaneous nephrostomy for emergency upper urinary tract decompression. *J Med Life*. 2023;16(5):663-667. doi:10.25122/jml-2022-0334
- [43] Szvalb AD, El Haddad H, Rolston KV, et al. Risk factors for recurrent percutaneous nephrostomy catheter-related infections. *Infection*. 2019;47(2):239-245. doi:10.1007/s15010-018-1245-y
- [44] Zul Khairul Azwadi I, Norhayati MN, Abdullah MS. Percutaneous nephrostomy versus retrograde ureteral stenting for acute upper obstructive uropathy: a systematic review and meta-analysis. *Sci Rep*. 2021;11(1):6613. Published 2021 Mar 23. doi:10.1038/s41598-021-86136-y
- [45] Gonçalves MS, Adragão T, Negrão AP, Simões JJ. Interesse da nefrostomia percutânea em nefrologia [Value of percutaneous nephrostomy in nephrology]. *Acta Med Port*. 1992;5(10):533-537.
- [46] Trifunovski A, Severova G, Atanasova A, et al. Percutaneous Nephrostomy as a Procedure in the Treatment of Urinary Tract Obstruction - Experiences in the University Clinic of Urology in Skopje. *Pril (Makedon Akad Nauk Umet Odd Med Nauki)*. 2024;45(1):31-40. Published 2024 Apr 4. doi:10.2478/prilozi-2024-0004