ŁUKASZEWSKA, Ewa, JASIUK, Ilona and CHROŚCIŃSKI, Kamil. Transrectal ultrasound (TRUS) as a diagnostic tool for abscesses and fistulas of the anus. Anatomy and methodology of the TRUS examination. Journal of Education, Health and Sport. 2024;68:55216. eISSN 2391-8306.
https://dx.doi.org/10.12775/JEHS.2024.68.55216
https://apcz.umk.pl/JEHS/article/view/55216

The journal has had 40 points in Minister of Science and Higher Education of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of 05.01.2024 No. 32318. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical culture sciences (Field of medical and health sciences); Health Sciences (Field of medical and health sciences).
Punkty Ministerialne 40 punktów. Załącznik do komunikatu Ministra Nauki i Szkolnictwa Wyższego z dnia 05.01.2024 Lp. 32318. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).
The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 15.08.2024. Revised: 17.09.2024. Accepted: 21.09.2024. Published: 24.09.2024.

Transrectal ultrasound (TRUS) as a diagnostic tool for abscesses and fistulas of the anus. Anatomy and methodology of the TRUS examination

Authors:

Ewa Łukaszewska [EŁ]

VOXEL NZOZ MCD, ul. Paderewskiego 5, 37-100 Łańcut, Poland

lukaszewska.ewapaulina@gmail.com

https://orcid.org/0009-0000-6065-7213

Ilona Jasiuk [IJ]

Independent Public Clinical Hospital No.1 in Lublin, Stanisława Staszica 16, 20-400 Lublin, Poland

ilona.jasiuk@gmail.com

https://orcid.org/0009-0009-8544-3276

Kamil Chrościński [KC]

Independent Public Clinical Hospital No.1 in Lublin, Stanisława Staszica 16, 20-400 Lublin, Poland

kamilchr@onet.pl

https://orcid.org/0009-0000-0468-7901

Abstract:

Introduction

Transrectal ultrasound (TRUS) is a valuable imaging technique used to diagnose abscesses and fistulas in the anorectal region. It provides detailed visualization of soft tissues and anatomical structures, making it a crucial tool for assessing conditions that are often challenging to diagnose with other methods. Our work explores the anatomy relevant to TRUS and outlines the methodology of the examination, emphasizing its importance in the accurate detection and treatment planning of anorectal disorders.

Aim of the study

To evaluate the effectiveness of transrectal ultrasound (TRUS) as a diagnostic tool for identifying and assessing abscesses and fistulas in the anorectal region.

Methods and materials

This review was conducted based on available data published in the PubMed database, using the following phrases: "TRUS", „abscess", „diagnosis of fistulas", and "anorectal disorders".

Conclusion

Transrectal ultrasound (TRUS) has proven to be a highly effective diagnostic tool for the detection and evaluation of abscesses and fistulas in the anorectal region. Its ability to provide clear visualization of soft tissues and complex anatomical structures enhances diagnostic accuracy, facilitating more precise treatment planning. By outlining the anatomical context and proper methodology for TRUS, this study highlights the technique's value in improving clinical outcomes for patients with anorectal disorders. Further research and refinement of TRUS protocols may continue to optimize its diagnostic potential.

Keywords: Transrectal ultrasound (TRUS), diagnostic imaging, anorectal anatomy, anorectal abscess, anal fistula.

1. Introduction

Diseases of the anal canal are a common reason for patients to visit surgical clinics. They manifest as pain, itching, redness, discharge of purulent or bloody fluid, and in advanced cases, general inflammatory symptoms such as fever. Standard proctological examination is often insufficient for diagnosing these conditions. Increasingly, a more precise evaluation using ultrasound is needed [2]. The

most common causes of symptoms in patients are anal fissures, abscesses, and fistulas. Performing endosonography is an excellent method for preoperative diagnosis, allowing for the determination of the type and location of the condition and subsequently aiding surgeons in treatment.

2. **Etiopathogenesis**

Abscesses and fistulas in the anorectal region are typically the result of infections originating in the anal glands, which can become obstructed and lead to the formation of abscesses [7]. These infections, if untreated, may spread to surrounding tissues, leading to fistula formation. The underlying causes of these conditions often include trauma, chronic inflammation, or conditions like Crohn's disease, tuberculosis, or diabetes, which weaken the immune response [8]. Recurrent infections and improper drainage can further complicate the development of abscesses and fistulas [2,4]. Understanding the etiopathogenesis is crucial for selecting appropriate diagnostic tools, such as TRUS, to identify the extent and origin of the disease and guide effective treatment strategies.

3. **Anatomy of the Anal Canal**

A thorough understanding of the structure of the anal canal is crucial for identifying the primary source of disease. Accurate determination of its topography and precise description of any abnormalities significantly influence the success of surgical interventions. [1]

The anal canal, averaging 4-5 cm in length, is an extension of the rectum and terminates at the anus. The structure includes 5-10 longitudinal ridges known as anal columns (also called Morgagni's columns), which are connected at the bottom by anal valves [9]. These valves define the anal sinuses, located deeper between the valves and the wall of the anal canal [2]. The mucous membrane lining the canal is divided into three zones by the pectinate line and the intersphincteric groove.

The pectinate line extends along the anal valves, creating ridges on the surface of the anal columns. The intersphincteric groove is located approximately 2 cm above the anus and is also referred to as Hilton's line. This line marks the boundary between the internal and external anal sphincter muscles [10].

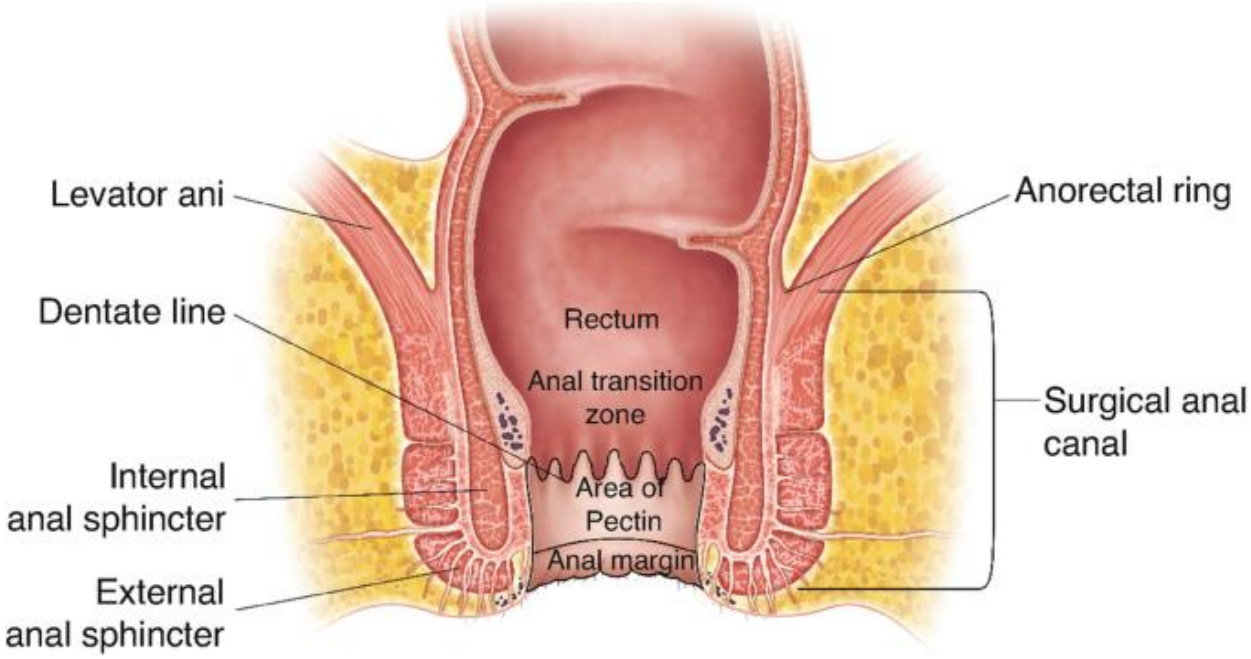

Image 1: Anal canal anatomy - https://link.springer.com/chapter/10.1007/978-981-19-5825-0_2

4. **Diagnostics of Anorectal Disorders**

The diagnosis of anorectal disorders should begin with a detailed medical history. It is important to assess symptoms such as bleeding, perineal or abdominal pain, and the nature of bowel movements, along with evaluating the patient's BMI, family history, and past or current medical conditions [3]. Suspected lower gastrointestinal tract disorders often lead to an initial proctological examination. A digital rectal exam (DRE) aims to assess the anus, anal canal, rectal ampulla, rectovesical or rectouterine pouch, and the presacral area [3]. During the examination, the clinician evaluates sphincter tone, the location of lesions causing symptoms, presence of tumors, rectal prolapse, the Douglas pouch, and the prostate gland [12].

The diagnostic process for anorectal diseases includes endoscopic examinations, functional tests of the lower gastrointestinal tract, and radiological imaging. Endosonography has become one of the most important preoperative diagnostic methods for abscesses and fistulas in the anal canal [12]. However, this method is currently less commonly used due to the lack of training for doctors, with magnetic resonance imaging (MRI) often used as an alternative.

Regarding Magnetic Resonance Imaging (MRI), it has become an invaluable tool in the diagnosis and management of anorectal abscesses and fistulas [13]. While traditionally used for

assessing the extent and complexity of these conditions, MRI offers several alternative applications that enhance its utility in clinical practice.

1. Preoperative Planning: MRI provides detailed anatomical information that helps in planning surgical interventions. Its high-resolution imaging capabilities allow surgeons to visualize the precise location, size, and relationship of abscesses and fistulas to surrounding structures. This detailed mapping aids in selecting the most effective surgical approach and minimizes the risk of complications [14].
2. Assessment of Treatment Response: Post-treatment MRI can be used to evaluate the effectiveness of conservative or surgical therapies [14]. By comparing pre- and post-treatment images, clinicians can assess the resolution of abscesses, the closure of fistulas, and identify any residual or recurrent disease.
3. Detection of Complications: MRI is effective in identifying potential complications associated with anorectal abscesses and fistulas, such as secondary abscesses or the development of complex fistulous tracts. This helps in early detection and timely management of these complications [15].
4. Guiding Minimal Invasive Procedures: For patients undergoing minimally invasive procedures, such as seton placement or percutaneous drainage, MRI can provide critical information about the anatomy and positioning of the procedure [15]. This enhances precision and effectiveness, reducing the likelihood of procedural failure.
5. Chronic Disease Monitoring: In cases of chronic or recurrent anorectal conditions, MRI can be used to monitor disease progression or remission over time. This long-term monitoring helps in adjusting treatment plans based on the evolving clinical picture [16].

5. **Methodology of Transrectal Ultrasound Examination of the Anal Canal**

For transrectal ultrasound examination, no special preparation is required for the patient. In individuals suspected of rectal cancer, performing a phosphate enema is beneficial to clean the bowel, as it enhances visualization of the rectal wall. The patient lies on their left side with knees drawn towards the abdomen [17]. Another position used for the examination, especially in patients with anal sphincter insufficiency, is the knee-chest position.

The anal canal examination can be performed using a mechanical transducer with a rotating rigid cone, but electronic transducers are also used, including sector-segmental and sector-linear transducers from brands such as Kretztechnik, Aloka, and Hitachi. These transducers operate at a high frequency range of 5.0 to 10.0 MHz, allowing imaging of the anal canal wall tissues up to a depth of 2-4 cm [17]. In

some patients, transvaginal transducers can be used when severe pain in the anus prevents the insertion of a transrectal transducer. The examination allows visualization of the rectal folds, measurement of perineal and internal anal sphincter tissues, although this method is less accurate than anal ultrasound (AUS). [18]

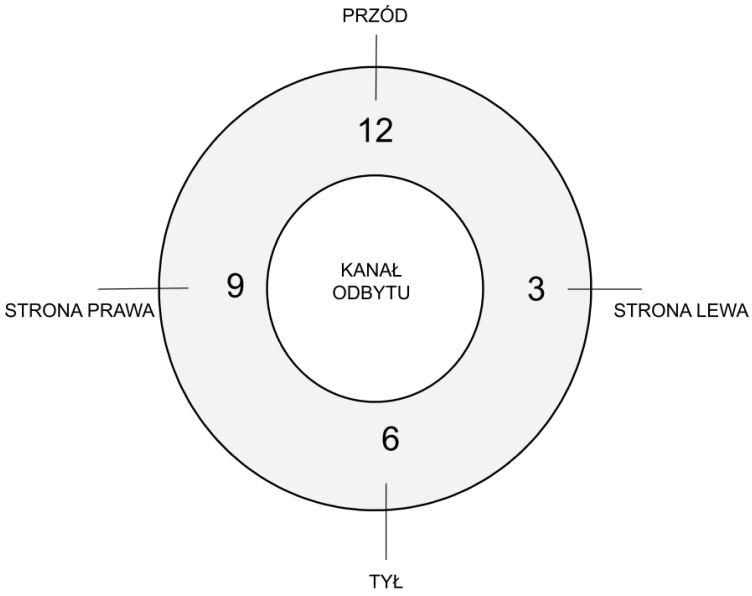

Image 2: Clock Face Diagram for Assessing Topography of Lesions in the Anal Canal, self work

The transducer, coated with gel, is gently inserted into the anus with a push-pull rotational motion. The distance of the transducer from the anal edge is determined based on the centimeter scale on the probe shaft. Once a good quality image is obtained, the ultrasound assessment is performed by making slow and gradual movements of the transducer in the distal and proximal directions along the entire long axis of the rectum, and in transverse sections of the anal canal and rectal ampulla [19]. If abnormalities are detected, their location is described using a clock face model: 12 o'clock corresponds to the anterior wall of the rectum, 3 o'clock to the left wall, 9 o'clock to the right wall, and 6 o'clock to the posterior wall [Fig. 1]. A characteristic landmark for orienting the transducer is the loop of the puborectalis muscle (PRM) with its arms open towards the perineum [19]

6. **Endosonographic Image of the Anal Canal**

The anal canal is divided into upper, middle, and lower sections, corresponding to the deep, superficial, and subcutaneous parts of the external anal sphincter, respectively. Additionally, in the upper section, the puborectalis muscle loops can be visualized, while in the middle section, the anorectal

ligament, the anal glands, the perineum, and the vagina in women can be seen [20]. This three-tiered division of the anal canal's structure is used in transrectal ultrasound terminology.

To assess anal fistulas and abscesses, it is essential to understand the layered structure of the anal canal:

- Submucosal layer
- Internal anal sphincter
- Inter-sphincteric space
- External anal sphincter and puborectalis muscle

The mucosa of the canal is usually not visible in the examination as it is a thin hypoechoic layer [20]. The first visible layer is the submucosa, which appears hypoechoic and up to 2 mm thick. Within this layer, anechoic structures corresponding to the hemorrhoidal cushions can be identified. The hypoechoic internal anal sphincter appears as an oval ring with a thickness ranging from 1.5 to 4 mm [21]. Its structure can be traced to the transition from the sphincter to the circular muscle of the rectum. The external anal sphincter, located peripherally from the internal sphincter, has a heterogeneous and higher echogenicity compared to the sphincter.

In men, the anal sphincter structure has more distinct boundaries and lower echogenicity compared to women. The average thickness of the anal sphincter wall is 9 mm in men and 8 mm in women, measured in the middle part of the canal. In men, the anal sphincter is symmetrical around the entire circumference, while in women, it is shorter on the anterior wall in the deep section, which may reflect a discontinuity of the sphincter in the transverse section [21, 22]. Between the anal sphincter and the sphincter is the longitudinal muscle, which is up to 3 mm thick in men and 3.5 mm in women, with echogenicity similar to the submucosal layer.

7. **TRUS Images - Abscesses and Fistulas of the Anal Canal**

The most common finding in TRUS (transrectal ultrasound) is the presence of abscesses and fistulas, which coexist in 50% of patients. Often, fistulas associated with abscesses or vice versa may go unrecognized due to inflammatory reactions around the fistula, leading to recurrences following incomplete treatment [23].

An abscess appears as an anechoic or hypoechoic lesion and may contain hyperechoic reflections characteristic of gas, usually surrounded by a hyperechoic rim. Single abscesses are most commonly observed, while complex abscesses in multiple anatomical spaces and horseshoe-shaped abscesses encircling the anal canal are less commonly seen. It is crucial to accurately determine the type and location of the abscess [23, 24].

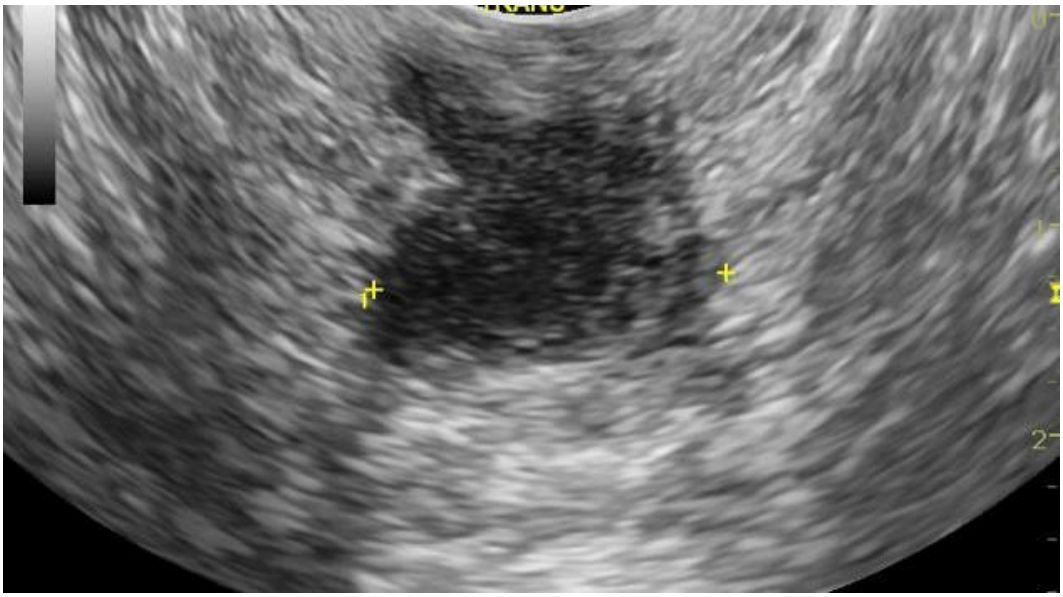

Image 3: Anal abscess by transrectal ultrasound Patel M, Perianal abscess. Case study, Radiopaedia.org (Accessed on 15 Sep 2024) https://doi.org/10.53347/rID-21116

In anal fistula appears as a hypoechoic or anechoic lesion. Within the fistula, ultrasound images may show hyperechoic strands corresponding to fluid or gas content. In another case, a comet-tail artifact may be observed as hyperechoic reflections, which significantly improves the detection of the fistula. During the examination, it is important to determine the type of fistula, its opening location, assess its nature (simple or complex), and evaluate its position [23].

The most commonly used classification is Parks' classification, which defines the direction and relationship of the fistula canal to the sphincter muscles and the levator ani muscle. Fistulas are categorized as intersphincteric, transsphincteric, suprasphincteric, and extrasphincteric.

8. **The Contribution of TRUS in the Treatment of Anal Fistulas and Abscesses**

Treatment Options for Anal Abscesses:

1. Incision and Drainage (I&D):

- Description: The primary treatment for an anal abscess is surgical drainage. This involves making an incision to release pus and relieve pressure.
- Role of TRUS: TRUS can help identify the exact location and extent of the abscess, ensuring accurate incision and effective drainage. It can also guide the choice of the incision site and assess the depth and complexity of the abscess [5].

2. Antibiotics:

- Description: Antibiotics may be used to treat or prevent infection, especially in conjunction with drainage.
- Role of TRUS: While TRUS does not directly influence antibiotic therapy, it helps monitor the abscess's response to treatment by evaluating its resolution or recurrence [25].

Treatment Options for Anal Fistulas:

1. Fistulotomy:

- Description: This surgical procedure involves cutting open the entire length of the fistula tract to allow it to heal from the inside out.
- Role of TRUS: TRUS is crucial for mapping the fistula's path and understanding its relationship with the anal sphincters and surrounding tissues [25, 26]. This information helps surgeons plan the most effective approach for fistulotomy and avoid damage to critical structures.

2. Seton Placement:

- Description: A seton is a piece of surgical thread placed through the fistula to keep it open and allow for gradual drainage and healing.
- Role of TRUS: TRUS can help in determining the appropriate placement of the seton by providing detailed images of the fistula's anatomy. It ensures that the seton is placed correctly and can be used to monitor the fistula's response to this treatment [26].

3. Fistulectomy:

- Description: This procedure involves the complete surgical removal of the fistula tract.
- Role of TRUS: TRUS assists in assessing the extent and complexity of the fistula, aiding in planning the surgical approach and ensuring complete removal of the fistula tract [27].

4. Advancement Flap Repair:

- Description: This technique involves covering the internal opening of the fistula with a flap of tissue taken from the surrounding area.

- Role of TRUS: TRUS can help evaluate the fistula's anatomy and ensure that the flap repair is performed correctly by providing detailed preoperative and postoperative images [24, 25].

5. Ligation of the Fistula Tract (LIFT):

- Description: This method involves identifying and ligating the fistula tract's internal opening, allowing it to close.
- Role of TRUS: TRUS is used to visualize the fistula tract and its relationship with the sphincter muscles, which is crucial for the successful application of the LIFT procedure [26].

Overall Role of TRUS in Treatment:

- Preoperative Planning: TRUS provides detailed anatomical information that helps in planning the surgical approach, identifying the extent of the abscess or fistula, and assessing its relationship with surrounding structures [28].
- Guidance During Surgery: Real-time imaging during surgery can help guide the procedure, ensuring accuracy in incision, drainage, and fistula management.
- Postoperative Monitoring: TRUS is useful in evaluating the success of treatment, detecting any residual or recurrent abscesses or fistulas, and guiding further management if needed [29].

In summary, TRUS is a valuable tool in the management of anal abscesses and fistulas, providing essential information for accurate diagnosis, effective treatment planning, and monitoring of outcomes.

8. **Summary**

Transrectal ultrasound (TRUS) is a critical diagnostic tool for evaluating abscesses and fistulas of the anus. This imaging technique provides detailed visualization of the anal canal and surrounding structures, enabling precise diagnosis and treatment planning [30].

The anal canal is divided into three distinct sections:

- Upper: Corresponds to the deep part of the external anal sphincter.
- Middle: Corresponds to the superficial part of the external anal sphincter.
- Lower: Corresponds to the subcutaneous part of the external anal sphincter.

In addition to these sections, TRUS can reveal anatomical structures such as the puborectalis muscle in the upper section, the anorectal ligament, anal glands, perineum, and vagina in women [30, 31].

Methodology of TRUS Examination:

- Preparation: No special preparation is typically required for the patient. However, a phosphate enema may be used in cases of suspected rectal cancer to enhance visualization.
- Positioning: The patient is usually positioned on their left side with knees drawn towards the abdomen. Alternatively, the knee-chest position may be used, especially in cases of anal sphincter insufficiency [32, 34].
- Transducers: TRUS utilizes various transducers, including mechanical rotating transducers and electronic sector or linear transducers, with frequencies ranging from 5.0 to 10.0 MHz. This high frequency allows for detailed imaging of the anal canal wall up to 2-4 cm in depth [33]. In some cases, transvaginal transducers may be employed if transrectal insertion is painful.
- Procedure: The transducer, coated with gel, is gently inserted into the anus. Measurements and imaging are taken in both longitudinal and transverse planes to assess the anal canal and surrounding structures [32]. The presence of abscesses and fistulas is evaluated based on their echogenicity and anatomical location.

Diagnosis and Classification:

- Abscesses: Appearing as anechoic or hypoechoic lesions, abscesses may contain gas or fluid, and are often surrounded by a hyperechoic rim. Accurate identification and localization of abscesses are crucial for effective treatment [35].
- Fistulas: Fistulas are typically seen as hypoechoic or anechoic lesions with possible hyperechoic strands indicating gas or fluid. The Parks classification is commonly used to categorize fistulas based on their relationship to the sphincter muscles and the levator ani muscle, distinguishing them as intersphincteric, transsphincteric, suprasphincteric, or extrasphincteric [36].

Overall, TRUS provides essential information for diagnosing and managing anal abscesses and fistulas, guiding treatment strategies and improving patient outcomes.

Author's contribution:

Conceptualization, supervision, and project administration:

Ewa Łukaszewska, Ilona Jasiuk

Methodology:

Ewa Łukaszewska, Kamil Chróściński

Software, validation, formal analysis, investigation, resources, writing original draft preparation: Ilona Jasiuk, Kamil Chróściński,

Writing review editing and visualization:

Ewa Łukaszewska

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

Funding:

This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: Not applicable.

Conflict of Interest: The authors declare no conflict of interest.

References

1. Narkiewicz, O., Moryś, J. Human Anatomy, Volume 3. PZWL Medical Publishers,2010:8.10: 260-266

2. Kołodziejczak, M., Sudoł-Szopińska, I.. Diagnosis and Treatment of Abscesses and Fistulas. PZWL Medical Publishers, 2008:4:42-57

3. Sudoł-Szopińska, I. Endosonography in the Diagnosis of Rectal and Anal Canal Diseases. PZWL Medical Publishers, 2021:2-3:23-58

4. Kołodziejczak M., Ciesielski P. Treatment of anal fistula – a review of recent 2023/2024 reports, 1/2024, 18-25 | DOI: 10.25121/NM.2024.31.1.18

5. Patel, M. Perianal abscess. Case study. Radiopaedia.org. Accessed September 15, 2024. https://doi.org/10.53347/rID-21116

6. Mitterberger M, Horninger W, Aigner F, Pinggera GM, Steppan I, Rehder P, Frauscher F. Ultrasound of the prostate. Cancer Imaging. 2010 Mar 3;10(1):40-8. doi: 10.1102/1470-7330.2010.0004. PMID: 20199941; PMCID: PMC2842183.

7. Gordon. Principles and Practice of Surgery for the colon, rectum and anus. 4 ed. 2019

8. Beck, David & Steele, Scott & Wexner, Steven. Fundamentals of Anorectal Surgery. 2019. 10.1007/978-3-319-65966-4.

9. Standring, S., Gray's Anatomy: The Anatomical Basis of Clinical Practice. 2020

10. Vishy Mahadevan, The anatomy of the rectum and anal canal, Surgery, 2011-01-01, Volume 29, Issue 1, Pages 5-10, Copyright © 2010 Elsevier Ltd

11. Stoker J. Anorectal and pelvic floor anatomy. Best Pract Res Clin Gastroenterol. 2009;23(4):463-75. doi: 10.1016/j.bpg.2009.04.008. PMID: 19647683.

12. Schubert MC, Sridhar S, Schade RR, Wexner SD. What every gastroenterologist needs to know about common anorectal disorders. World J Gastroenterol. 2009 Jul 14;15(26):3201-9. doi: 10.3748/wjg.15.3201.

13. Givel, J.-C.R. & Mortensen, Neil & Roche, B. Anorectal and colonic diseases: A practical guide to their management. 2010, doi:10.1007/978-3-540-69419-9.

14. Robin K.S.Philips, Colorectal Surgery, A Companion to Specialist Surgical Practice, Saunders, 2002

15. Whitehead WE, Wald A, Diamant NE, Enck P, Pemberton JH, Rao SS., Functional disorders of the anus and rectum.Gut. 1999 Sep;45 Suppl 2(Suppl 2):II55-9. doi:10.1136/gut.45.2008.ii55.

16. Daniluk P, Mazur N, Swierblewski M, Chand M, Diana M, Polom K. Fluorescence Imaging in Colorectal Surgery: An Updated Review and Future Trends. Surg Innov. 2022 Aug;29(4):479-487. doi: 10.1177/15533506211072678. Epub 2022 Mar 1. PMID: 35232304.

17. Zhao WW, Yu J, Shu J, Sha JT, Li CY, Zeng J, Zheng Y, Wang XQ, Quan ZY, Yang Y. Precise and comprehensive evaluation of perianal fistulas, classification and related complications using magnetic resonance imaging. Am J Transl Res. 2023 May 15;15(5):3674-3685. PMID: 37303685;

18. Jimenez M, Mandava N. Anorectal Fistula. [Updated 2023 Feb 2]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK560657/

19. M. Davis MD, Prof. Emeritus of Radiology, Jeffrey D. Houston MD, Department of Radiology, Unive, Fundamentals Gastroinstestinal Radiology, 2001

20. Carter, D.; Ram, E.; Engel, T. Combined 3D Endoanal Ultrasound and Transperineal Ultrasound Improves the Detection of Anal Sphincter Defects. Diagnostics 2023, 13, 682. https://doi.org/10.3390/diagnostics13040682.

21. Waqar Qureshi, Diagnosis and Management Guide for Anorectal Disease A Clinical Reference, 2019:4

22. Momchilova, Monika & Maslyankov, Svilen & Popov, Tsvetan & Pavlov, Vasil & Arabadjiev, Angel & Sokolov, Manol. Clinical Application Of Endoanal And Endorectal Ultrasound For Benign And Malignant Conditions Of The Anus, Perianal Space, And Rectum. Scripta Scientifica Medica. 2023, 55. 49. 10.14748/ssm.v55i0.9357.

23. Zhao WW, Yu J, Shu J, et al. Precise and comprehensive evaluation of perianal fistulas, classification and related complications using magnetic resonance imaging. Am J Transl Res 2023; 15: 3674–3685.

24. Zhang C, Zhang X, Zhao X, et al. The Value of Transrectal Ultrasound in the Preoperative Diagnosis of Complex Anal Fistula (CAF): Based on a Retrospective Cohort Study. Comput Math Methods Med 2022; 2022: 6411935. DOI: 10.1155/2022/6411935.

25. Robert J. Rowe, M.D., M.S. and Elinor Reinmiller, Review of literature on diseases of the colon and rectum. 1958, Dis Colon Rectum 1, 311–322 https://doi.org/10.1007/BF02617068

26. Herold, A. Anorectal Abscess and Fistula. In: Herold, A., Lehur, PA., Matzel, K., O'Connell, P. (eds) Coloproctology. European Manual of Medicine. Springer, Berlin, 2017, Heidelberg. https://doi.org/10.1007/978-3-662-53210-2_6

27. Steele SR, Kumar R, Feingold DL, Rafferty JL, Buie WD; Standards Practice Task Force of the American Society of Colon and Rectal Surgeons. Practice parameters for the management of perianal abscess and fistula-in-ano. Dis Colon Rectum. 2011 Dec;54(12):1465-74. doi: 10.1097/DCR.0b013e31823122b3. PMID: 22067173.

28. Sturiale, A., Fabiani, B., Celedon Porzio, F., Brusciano, L., Menconi, C., Naldini, G. Anorectal Physiology Assessment in Patients with Anal Fistula: When Necessary. In: Ratto, C., Parello, A., Litta, F., De Simone, V., Campennì, P. (eds) Anal Fistula and Abscess. Coloproctology. Springer, Cham. 2021, https://doi.org/10.1007/978-3-030-30902-2_11-1

29. Hawkins AT, Rothman RL, Geiger TM, Canedo JR, Edwards-Hollingsworth K, LaNeve DC, Penson DF. Patient-Reported Outcome Measures in Colon and Rectal Surgery: A Systematic Review and Quality Assessment. Dis Colon Rectum. 2020 Aug;63(8):1156-1167. doi: 10.1097/DCR.0000000000001717. PMID: 32692077; PMCID: PMC8029646.

30. Goldberg H, Ahmad AE, Chandrasekar T, Klotz L, Emberton M, Haider MA, Taneja SS, Arora K, Fleshner N, Finelli A, Perlis N, Tyson MD, Klaassen Z, Wallis CJD. Comparison of Magnetic Resonance Imaging and Transrectal Ultrasound Informed Prostate Biopsy for Prostate Cancer Diagnosis in Biopsy Naïve Men: A Systematic Review and Meta-Analysis. J Urol. 2020 Jun;203(6):1085-1093. doi: 10.1097/JU.0000000000000595. Epub 2019 Oct 14. PMID: 31609177.

31. Grant M. Baxter, Paul S. Sidhu, Ultrasound of the Urogenital System,Georg Thieme, 2006, ISBN: 9783131374417

32. Grey, A., Connor, M., Tam, J., & Loch, T. Can transrectal prostate ultrasound compete with multiparametric MRI in the detection of clinically significant prostate cancer? Translational Andrology and Urology, 2020, 9(3), 1492-1500. doi:10.21037/tau.2020.02.26

33. Frankel H. Ultrasound in Surgical Practice: Basic Principles and Clinical Applications. Ann Surg. 2002 Aug;236(2):261–2. PMCID: PMC1422576.

34. Ammar T, Sidhu PS, Wilkins CJ. Male infertility: the role of imaging in diagnosis and management. Br J Radiol. 2012 Nov;85 Spec No 1(Spec Iss 1):S59-68. doi: 10.1259/bjr/31818161. Epub 2012 Jul 4. PMID: 22763036; PMCID: PMC3746399.

35. Stabile A, Giganti F, Rosenkrantz AB, Taneja SS, Villeirs G, Gill IS, Allen C, Emberton M, Moore CM, Kasivisvanathan V. Multiparametric MRI for prostate cancer diagnosis: current status and future directions. Nat Rev Urol. 2020 Jan;17(1):41-61. doi: 10.1038/s41585-019-0212-4. Epub 2019 Jul 17. PMID: 31316185.

36. PDQ Adult Treatment Editorial Board. Prostate Cancer Treatment (PDQ®): Health Professional Version. 2024 Aug 9. In: PDQ Cancer Information Summaries [Internet]. Bethesda (MD):

National Cancer Institute (US); 2002-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK66036/.