SOWIŃSKI, Wojciech, WALENTYN, Wiktoria, WACHOWSKA, Maria, MOLENDA, Marek, WOSZCZYŃSKA, Oliwia, RYCĄBEL, Paweł, ROMANIUK, Mateusz, PANIAK, Mateusz, SZYMURA, Marta, WOJCIECHOWSKA, Agnieszka, KRAWCZYK, Michał and ZDYBEL, Michał. Varicocele - literature review. Quality in Sport. 2025;40:59540. eISSN 2450-3118.
https://doi.org/10.12775/QS.2025.40.59540
https://apcz.umk.pl/QS/article/view/59540

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 declare that there is no conflict of interests regarding the publication of this paper.
Received: 17.03.2025. Revised: 01.04.2025. Accepted: 04.04.2025 Published: 07.04.2025.

Varicocele – literature review

Wojciech Jan Sowiński
1st Military Clinical Hospital with the Outpatient Clinic, Lublin, Poland
ORCID: 0000-0002-2267-4773
wojciechjansowinski@gmail.com

Wiktoria Walentyn
Medical University of Lublin, Medical Department, Al. Racławickie 1, 20-059 Lublin, Poland
ORCID: 0009-0002-5649-5340
wiktoriawalentyn@gmail.com

Maria Wachowska
Podhale Specialist Hospital named after St John Paul II in Nowy Targ, ul. Szpitalna 14, 34-400 Nowy Targ, Poland
ORCID: 0009-0004-2069-9469
maria.wac97@gmail.com

Marek Jarosław Molenda
4th Clinical University Hospital in Lublin, ul. Kazimierza Jaczewskiego 8, 20-954 Lublin, Poland
ORCID: 0009-0002-7900-4970
markollo1998@gmail.com

Oliwia Brygida Woszczyńska
Independent Public Health Care of the Ministry of the Internal Affairs, ul. Kartuska 4/6, 80-104 Gdańsk, Poland
ORCID: 0009-0001-7724-544X
ob.woszczynska@gmail.com

Paweł Maciej Rycąbel
Independent Public Health Care Center of the Polish Ministry of Interior and Administration in Lublin, ul. Grenadierów 3, 20-331 Lublin, Poland
ORCID: 0009-0008-4039-8312
pawelrycabel@gmail.com

Mateusz Romaniuk
Independent Public Health Care Center of the Polish Ministry of Interior and Administration in Lublin, ul. Grenadierów 3, 20-331 Lublin, Poland
ORCID: 0009-0007-1486-5522
mateusz.romaniuk.44@gmail.com

Mateusz Paniak
Cardinal Stefan Wyszyński Province Specialist Hospital in Lublin, ul. al. Kraśnicka 100, 20-718 Lublin
ORCID: 0009-0009-0110-9634
mateuszpaniak.mp@gmail.com

Marta Szymura
Independent Public Healtcare Center No.1 in Rzeszów, ul. Tadeusza Czackiego 2 35-051 Rzeszów
ORCID: 0009-0000-2776-8974
martaszymura3581@gmail.com

Agnieszka Ewelina Wojciechowska
Cardinal Stefan Wyszyński Province Specialist Hospital in Lublin, ul. al. Kraśnicka 100, 20-718 Lublin
ORCID: 0009-0009-3344-9115
ine.wojciechowska@gmail.com

Michał Brunon Krawczyk
Pediatric Cardiac Surgery Department of Mikołaj Kopernik Hospital in Gdańsk, Gdańsk, Poland
ORCID: 0009-0008-9697-6548
michalkrawczyk@gumed.edu.pl

Michał Zdybel
Fryderyk Chopin University Clinical Hospital in Rzeszów, ul. Fryderyka Szopena 2, 35-055 Rzeszów, Poland
ORCID: 0000-0002-9037-4350
michuuu223@gmail.com

Abstract

Introduction and objective

Varicocele is the most common reversible cause of male infertility. This article describes the entire disease entity, in particular the pathophysiology and potential methods of treating this condition.

Review methods

A literature review was conducted using the PubMed database to gather knowledge about varicocele. The main search terms were „varicocele", „varicocele pathophysiology" and „varicocele treatment".

Description of the state of knowledge

Varicocele is usually asymptomatic, and in other cases may cause nonspecific symptoms, such as discomfort or pain in the scrotum. Diagnosis is based on physical examination, and in doubtful cases, ultrasound can be used. There are several theories about the development of varicocele. These include the anatomical, nutcracker, embryological, or valve-related theories. Impaired blood flow from the testicles leads to oxidative stress and hyperthermia, which affects the deterioration of sperm quality. The most common indication for treating varicocele is difficulty getting pregnant. In such cases, non-pharmacological treatment is used.

Conclusions

The surgical techniques used differ in the frequency of complications, their type, and the percentage of improvement in semen parameters. Despite numerous successes in the treatment of varicocele, there remains a large group of patients who still have problems having children.

Keywords: Varicocele, varicocele pathophysiology, varicocele treatment

Introduction:

Varicocele affects up to 15% of the male population, and its incidence reaches up to 35% in men with abnormal semen parameters. [1] In as many as 85% of cases, they affect only the left side, and in the remaining cases, they are bilateral. They are usually asymptomatic, but in other cases they may cause a feeling of heaviness or pain in the scrotum. This is the most common reversible cause of male infertility. [2], [3]

Definition:

Varicocele is an abnormal dilatation of the lumen of the venous vessels of the spermatic cord. Increased blood flow causes temperature to rise what can lead to some problems with fertility. We can distinguish three grades of varicocele. 1) perceptible varicocele during Valsalva maneuver in a standing position 2) perceptible varicocele without Valsalva maneuver in a standing position 3) Varicocele visible through the skin of the scrotum [4]

Grade	Description
1	Palpable only with the patient standing and performing a concurrent Valsalva maneuver
2	Palpable with the patient standing, without a Valsalva maneuver
3	Visible through the scrotal skin and palpable with the patient standing

Table 1: Clinical grading system defined by Dubin and Amelar

Epidemiology

Varicocele are present among 15% of general adult and adolescent male population. Frequency of occurrence increases among males with primary infertility to 25-35% and secondary infertility to 80%. There are rarely detected varicocele among children under age of 10 and they begin to occur during puberty. The correlation between age and prevalence remains strong and increases by 10% every decade. [5]

Diagnosis:

The main method for diagnosing varicocele remains a physical examination of the srotum. The examination should be performed in a warm place and a friendly environment, as cold and stress may cause scrotal contraction and may falsify the examination. The examination is performed in a standing position and physician tries to feel dilation of the veins. Patient may be asked to exhale air forcefully what is called Valsalva maneuver. Based on the examination, the presence of varicocele and its grade can be determined. Ultrasound is also a useful diagnostic tool, which allows for better visualization of varicocele and differentiation with other pathologies. Due to its ease of use and high sensitivity, it is widely used among urologists. Ultrasonography seems to be superior to Prader orchidometers and venography but physical examination remains gold standard for diagnosing varicocele and USG should be used only in uncertain cases. [6] [7]

Pathogenesis:

The pathogenesis of varicocele remains not fully understood, but there are several theories that may explain the way they develop. [8]

Anatomical theory

In most cases, varicocele occurs only on the left side. The main cause may be the anatomy of the spermatic veins. The left spermatic vein is longer than the right one by about 8-10 cm, which makes it easier to dilate. Additionally, it enters the renal vein at a right angle, which also impedes blood flow from this vessel. [8] [9]

Nutcracker syndrome theory

There is a theory that connects the development of varicocele with the so-called nutcracker syndrome. Compression of the left renal vein by the aorta and superior mesenteric artery leads to an increase in hydrostatic pressure in the internal spermatic vein. This results in reflux and dilatation of the pampiniform plexus. [8] [10]

Valve theory

In the course of the spermatic vein, there is often a reduced number or even absence of valves preventing reverse blood flow. However, the existing ones often have disturbed structure and functionality. This may be the main cause of reflux in these vessels. [8] [11]

Embryological theory

During embryonic development, the spermatic vein, adrenal veins and renal vein join into one renal vein. This may cause overload of the venous system, resulting in the formation of varicocele during puberty. [8]

Pathophysiology:

Despite some evidence of a negative impact of varicocele on spermatogenesis and semen parameters, the pathophysiology is not fully understood. Possible mechanisms involved in the development of varicocele are presented below. [12]

Testicular hyperthermia

Spermatogenesis is a process very sensitive to temperature fluctuations and is most effective at 35-36 degrees. [12] The pampiniform plexus is responsible for maintaining the appropriate temperature in the scrotum, which is able to lower the temperature by about 1-2 degrees. [8] It is not fully known how hyperthermia affects the process of spermatogenesis, but it is suspected to damage DNA and the structure of seminiferous tubule cells and Leydig cells. Men with varicocele have a higher temperature inside the scrotum compared to healthy men, which results from impaired blood outflow through the spermatic vein. Despite this, the temperature in the scrotum is on average 0.3 degrees higher on the varicocele side. Interestingly, there was no significant difference in scrotal temperature between men with varicocele and those with post varicocelectomy in the supine position. A higher temperature appeared only in the group with varicocele after assuming a standing position. Although varicocele occurs in the vast majority of cases on the left side, histopathological examinations often did not show significant differences between the left and right testicle. [13]

Oxidative stress:

Patients with varicocele usually have higher levels of ROS than healthy people. It has been proven that ROS adversely affects the structure and function of sperm by denaturing proteins, fatty acids and DNA. Oxidation of the fatty acid-rich cell membrane causes a decrease in membrane fluidity and depletion of axonal proteins, which results in a decrease in sperm motility. Apoptosis is also more intense, which translates into a decrease in the number of sperm and an increase in abnormal forms. Apoptosis can be intensified not only by ROS, but also by genetic factors and excess cadmium. This element induces apoptosis and its increased level is found in both testicles in patients with varicocele. [12] [14]

ROS also have deleterious effects on nuclear and mitochondrial DNA. It has been proven that removal of varicocele improves DNA integrity and the process of spermatogenesis itself. [12]

Symptoms:
Varicocele is usually asymptomatic, but some patients report certain symptoms. Most often it is pain, swelling or discomfort in the scrotum or groin. The symptoms worsen with age, physical activity or at the end of the day. [8] Some patients report the bag of worms symptom, which results from the dilatation of the veins. [6]

Treatment:
The most effective way of treating varicocele remains non-pharmacological methods using surgery and interventional radiology. Subinguinal varicocelectomy, retroperitoneal varicocelectomy or inguinal varicocelectomy remain surgical procedures while radiological interventions include embolization, sclerotherapy, the selective closure of dilated vessels using a balloon or coil. [15] The most common indication for surgery is reduced semen parameters causing problems with getting pregnant. The varicocele removal procedure aims to improve male fertility. The second most common indication is testicular atrophy. [16] Each surgical method statistically leads to an increase in pregnancy rates in patients with abnormal sperm parameters and clinical varicocele . However, depending on the method, this ratio may vary as well as the frequency of complications, including recurrence of varicocele or testicular hydrocele.

Sclerotherapy:
This method is relatively new and involves closing the lumen of the pathological vessel. This is achieved by injecting a sclerotizing agent, which leads to the destruction of the intima of the vessel and, consequently, its narrowing. [15]

Embolization
It is a minimally invasive method that involves injecting a sclerosant or using tissue adhesives or detachable metal coils. For left-sided varicocele, this method achieves similar results to surgical methods and even provides additional benefits of shorter recovery time and avoidance of complications caused by general anesthesia. However, this technique should not be suggested in patients with bilateral varicocele, as the failure rate reaches 13-19% compared to 5% using techniques microsurgical. This is most often due to failure to close the right gonadal vein. [17]

Laparoscopy
Laparoscopy is the most invasive method of treating varicocele and requires a great deal of experience and skill on the part of the operator. Although it is less likely to lead to complications such as hydrocele, the need for general anesthesia and the seriousness of other possible complications mean that it is not always a preferred method of treatment. The most serious complications include damage to the intestines, large abdominal vessels, and peritonitis. Another disadvantage of this technique is the inability to operate on the external spermatic veins, which often leads to recurrence of varicocele. [18]

Retroperitoneal varicocelectomy

Retroperitoneal varicocelectomy, also known as the supra inguinal method, is an open procedure that involves the dissection of the testicular artery and vein and their ligation. In no other technique are the vessels ligated so high. As most authors claim, this method is less likely to lead to varicocele recurrence and is preferred in patients who have previously undergone surgery for varicocele. The disadvantage of this procedure is the inability to spare the lymphatic vessels. [19]

Inguinal and subinguinal microsurgical varicocelectomy (SMV)

SMV is a recognized gold standard in surgical treatment of varicocele. For this reason, it is the most commonly used technique. It is less frequently associated with varicocele recurrence or other complications. In addition, the improvement in semen parameters and pregnancy rates after SMV is higher than with other techniques. [20] [21]

In some cases, the inguinal approach may be a better choice than the subinguinal approach. In thin, young patients, or those who have previously undergone SMV, the inguinal approach may be more beneficial. In addition, the inguinal approach is associated with fewer small-diameter vessels, which is somewhat easier for the operator. [20]

There is some uncertainty whether there is a difference in the quality of SMV with or without TD. Liao et al. conducted a meta-analysis in which they showed that both surgical techniques have similar effectiveness in terms of pregnancy rate, operation time, sperm concentration and sperm motility. However, MSV with TD had a lower rate of varicocele recurrence and lower postoperative testosterone levels at the cost of a higher rate of complications compared with MSV without TD. [22]

Conclusions:

Varicocele remains the most common reversible cause of male infertility. Despite the existence of many treatment techniques, mainly surgical, many patients still fail to conceive. For this reason, further research will be needed to improve the quality of treatment. A better understanding of the pathogens of varicocele will be helpful in this, as there are many theories about their formation.

Disclosure:

Statement of the authors' contribution

***Conceptualization*:** Wojciech Sowiński, Wiktoria Walentyn, Maria Wachowska, Marek Molenda, Oliwia Woszczyńska, Paweł Rycąbel, Mateusz Romaniuk, Mateusz Paniak, Marta Szymura, Agnieszka Wojciechowska, Michał Krawczyk, Michał Zdybel

***Methodology*:** Wojciech Sowiński, Wiktoria Walentyn, Maria Wachowska, Marek Molenda, Oliwia Woszczyńska, Paweł Rycąbel, Mateusz Romaniuk, Mateusz Paniak, Marta Szymura, Agnieszka Wojciechowska, Michał Krawczyk, Michał Zdybel

Software: Wojciech Sowiński, Wiktoria Walentyn, Maria Wachowska, Marek Molenda, Oliwia Woszczyńska, Paweł Rycąbel, Mateusz Romaniuk, Mateusz Paniak, Marta Szymura, Agnieszka Wojciechowska, Michał Krawczyk, Michał Zdybel

***Check*:** Wojciech Sowiński, Wiktoria Walentyn, Maria Wachowska, Marek Molenda, Oliwia Woszczyńska, Paweł Rycąbel, Mateusz Romaniuk, Mateusz Paniak, Marta Szymura, Agnieszka Wojciechowska, Michał Krawczyk, Michał Zdybel

***Formal analysis*:** Wojciech Sowiński, Wiktoria Walentyn, Maria Wachowska, Marek Molenda, Oliwia Woszczyńska, Paweł Rycąbel, Mateusz Romaniuk, Mateusz Paniak, Marta Szymura, Agnieszka Wojciechowska, Michał Krawczyk, Michał Zdybel

***Investigation*:** Wojciech Sowiński, Wiktoria Walentyn, Maria Wachowska, Marek Molenda, Oliwia Woszczyńska, Paweł Rycąbel, Mateusz Romaniuk, Mateusz Paniak, Marta Szymura, Agnieszka Wojciechowska, Michał Krawczyk, Michał Zdybel

***Resources, data curation*:** Wojciech Sowiński, Wiktoria Walentyn, Maria Wachowska, Marek Molenda, Oliwia Woszczyńska, Paweł Rycąbel, Mateusz Romaniuk, Mateusz Paniak, Marta Szymura, Agnieszka Wojciechowska, Michał Krawczyk, Michał Zdybel

***Writing - rough preparation*:** Wojciech Sowiński, Wiktoria Walentyn, Maria Wachowska, Marek Molenda, Oliwia Woszczyńska, Paweł Rycąbel, Mateusz Romaniuk, Mateusz Paniak, Marta Szymura, Agnieszka Wojciechowska, Michał Krawczyk, Michał Zdybel

***Writing - review and editing*:** Wojciech Sowiński, Wiktoria Walentyn, Maria Wachowska, Marek Molenda, Oliwia Woszczyńska, Paweł Rycąbel, Mateusz Romaniuk, Mateusz Paniak, Marta Szymura, Agnieszka Wojciechowska, Michał Krawczyk, Michał Zdybel

***Visualization*:** Wojciech Sowiński, Wiktoria Walentyn, Maria Wachowska, Marek Molenda, Oliwia Woszczyńska, Paweł Rycąbel, Mateusz Romaniuk, Mateusz Paniak, Marta Szymura, Agnieszka Wojciechowska, Michał Krawczyk, Michał Zdybel

***Supervision*:** Wojciech Sowiński, Wiktoria Walentyn, Maria Wachowska, Marek Molenda, Oliwia Woszczyńska, Paweł Rycąbel, Mateusz Romaniuk, Mateusz Paniak, Marta Szymura, Agnieszka Wojciechowska, Michał Krawczyk, Michał Zdybel

***Project administration*:** Wojciech Sowiński, Wiktoria Walentyn, Maria Wachowska, Marek Molenda, Oliwia Woszczyńska, Paweł Rycąbel, Mateusz Romaniuk, Mateusz Paniak, Marta Szymura, Agnieszka Wojciechowska, Michał Krawczyk, Michał Zdybel

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.

Conflicts of interest:
The authors declare no conflict of interest.

References:

1. Macleod R, Biyani CS, Cartledge J, Eardley I. Varicocele. BMJ Clin Evid. 2015 Jul 13;2015:1806. PMID: 26168774; PMCID: PMC4500994.
2. Biyani CS, Cartledge J, Janetschek G. Varicocele. BMJ Clin Evid. 2009 Jan 6;2009:1806. PMID: 19445764; PMCID: PMC2907779.
3. Pathak P, Chandrashekar A, Hakky TS, Pastuszak AW. Varicocele management in the era of in vitro fertilization/intracytoplasmic sperm injection. Asian J Androl. 2016 May-Jun;18(3):343-8. doi: 10.4103/1008-682X.178482. PMID: 27030086; PMCID: PMC4854076.
4. Dubin L, Amelar RD. Varicocele size and results of varicocelectomy in selected subfertile men with varicocele. Fertil Steril. 1970 Aug;21(8):606-9. doi: 10.1016/s0015-0282(16)37684-1. PMID: 5433164.
5. Alsaikhan B, Alrabeeah K, Delouya G, Zini A. Epidemiology of varicocele. Asian J Androl. 2016 Mar-Apr;18(2):179-81. doi: 10.4103/1008-682X.172640. PMID: 26763551; PMCID: PMC4770482.
6. Esteves SC. What is varicocele? Int Braz J Urol. 2023 Jul-Aug;49(4):525-526. doi: 10.1590/S1677-5538.IBJU.2023.04.06. PMID: 37267621.
7. Belay RE, Huang GO, Shen JK, Ko EY. Diagnosis of clinical and subclinical varicocele: how has it evolved? Asian J Androl. 2016 Mar-Apr;18(2):182-5. doi: 10.4103/1008-682X.169991. PMID: 26780869; PMCID: PMC4770483.
8. Słowikowska-Hilczer J. Andrologia. Zdrowie mężczyzny od fizjologii do patologii. In: Kupis Ł, Dobroński P, (Ed.). Żylaki powrózka nasiennego. Wydanie I. Warszawa PZWL Wydawnictwo Lekarskie 2022;569-587
9. Clavijo RI, Carrasquillo R, Ramasamy R. Varicoceles: prevalence and pathogenesis in adult men. Fertil Steril. 2017 Sep;108(3):364-369. doi: 10.1016/j.fertnstert.2017.06.036. PMID: 28865534.
10. Reddy DK, Shekar P A. Nutcracker Syndrome-A Rare but Important Cause of Varicocele in Adolescent Boys. Urology. 2020 Jul;141:143-146. doi: 10.1016/j.urology.2020.04.008. Epub 2020 Apr 16. PMID: 32305552.
11. Leslie SW, Sajjad H, Siref LE. Varicocele. [Updated 2023 Nov 13]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK448113/

12. Hassanin AM, Ahmed HH, Kaddah AN. A global view of the pathophysiology of varicocele. Andrology. 2018 Sep;6(5):654-661. doi: 10.1111/andr.12511. Epub 2018 Jul 6. PMID: 29978951.
13. Takihara H, Sakatoku J, Cockett AT. The pathophysiology of varicocele in male infertility. Fertil Steril. 1991 May;55(5):861-8. doi: 10.1016/s0015-0282(16)54288-5. PMID: 2022264.
14. Wang K, Gao Y, Wang C, Liang M, Liao Y, Hu K. Role of Oxidative Stress in Varicocele. Front Genet. 2022 Mar 23;13:850114. doi: 10.3389/fgene.2022.850114. PMID: 35401656; PMCID: PMC8984266.
15. Cannarella R, Cannarella V, Randazzo R, Crafa A, Compagnone M, Mongioì LM, Condorelli RA, Bagnara V, La Vignera S, Calogero AE. Comparison Between Varicocelectomy and Varicocele Sclerotherapy: Results of a Single-Center Observational Study. Life (Basel). 2024 Oct 24;14(11):1368. doi: 10.3390/life14111368. PMID: 39598167; PMCID: PMC11596005.
16. Chiba K, Ramasamy R, Lamb DJ, Lipshultz LI. The varicocele: diagnostic dilemmas, therapeutic challenges and future perspectives. Asian J Androl. 2016 Mar-Apr;18(2):276-81. doi: 10.4103/1008-682X.167724. PMID: 26698233; PMCID: PMC4770499.
17. Cassidy D, Jarvi K, Grober E, Lo K. Varicocele surgery or embolization: Which is better? Can Urol Assoc J. 2012 Aug;6(4):266-8. doi: 10.5489/cuaj.11064. PMID: 23093537; PMCID: PMC3433543.
18. Cayan S, Shavakhabov S, Kadioğlu A. Treatment of palpable varicocele in infertile men: a meta-analysis to define the best technique. J Androl. 2009 Jan-Feb;30(1):33-40. doi: 10.2164/jandrol.108.005967. Epub 2008 Sep 4. PMID: 18772487.
19. Persad E, O'Loughlin CA, Kaur S, Wagner G, Matyas N, Hassler-Di Fratta MR, Nussbaumer-Streit B. Surgical or radiological treatment for varicoceles in subfertile men. Cochrane Database Syst Rev. 2021 Apr 23;4(4):CD000479. doi: 10.1002/14651858.CD000479.pub6. PMID: 33890288; PMCID: PMC8408310.
20. Mehta A, Goldstein M. Microsurgical varicocelectomy: a review. Asian J Androl. 2013 Jan;15(1):56-60. doi: 10.1038/aja.2012.98. Epub 2012 Nov 12. PMID: 23147467; PMCID: PMC3739135.
21. Wang X, Wang R, Du Q, Pan B. Clinical effectiveness of microsurgical subinguinal varicocelectomy with enhanced recovery after surgery for varicocele. Transl Androl Urol. 2021 Oct;10(10):3862-3872. doi: 10.21037/tau-21-908. PMID: 34804828; PMCID: PMC8575574.
22. Liao B, Liu J, Chen S, Zhang Q, Xie C, Jiang G, Cui S, Wu T. Efficacy and Safety of Microsurgical Subinguinal Varicocelectomy with and without Testicular Delivery for Varicocele Patients: A Systematic Review and Meta-Analysis. Urol J. 2019 Oct 21;16(5):417-426. doi: 10.22037/uj.v0i0.5095. PMID: 31473994.