Peri- and postoperative complications and outcome after radical prostatectomy with open, laparoscopic, and robotic-assisted approach

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List of Abbreviation and Acronyms

ADT - androgen deprivation therapy

BMI - body mass index

CT – computed tomography scan

DRE - digital rectal examination

LRP – laparoscopic radical prostatectomy

MRI – magnetic resonance imaging

ORP – open radical prostatectomy

PSA - prostate specific antigen

PET-CT – positron emission tomography with computed tomography

RARP - robotic-assisted radical prostatectomy

Santorini plexus – prostatic venous plexus

1. Introduction

1.1 Prostate cancer – general information

1.1.1 Epidemiology

Prostate cancer is one of the most common diseases that affects men worldwide. It is the second most frequently diagnosed cancer in men and the fifth leading cause of death. In the early stages, prostate cancer may be frequently asymptomatic, and in some cases, active surveillance is enough to manage the disease. However, the risk of developing prostate cancer increases with age, and elderly men over 65 are most susceptible. Furthermore, African American men have a higher incidence rate and more aggressive types of prostate cancer compared to white men. There are many methods to reduce the risk of prostate cancer, such as eating a healthy diet that includes fewer high-fat foods and more vegetables and fruits and exercising regularly. (1)

1.1.2 Etiology

The etiology of prostate cancer is multifactorial and still unclear, yet there are various risk factors that may contribute to its development. These include age, ethnicity, family history, genetics, obesity, diet, hormones, smoking, alcohol, and certain medications. While none of these factors have been identified as definitive causes, studies have shown that they play a significant role in the development of prostate cancer. The incidence of prostate cancer increases with age, with men between the ages of 60 and 79 being the most affected.

Family history and genetics also play a role in the development of the disease, with the likelihood of prostate cancer increasing when multiple family members are affected. Additionally, ethnicity is a significant risk factor. The incidence, severity, and mortality rate are higher in men of black African descent compared to other ethnic groups.

Certain lifestyle and dietary habits, such as smoking, alcohol consumption, and obesity, can have a significant impact on the risk of developing prostate cancer. (2)

The risk of prostate cancer tends to increase with higher amounts of cigarette smoking and alcohol consumption.

Furthermore, there is a correlation between insulin growth factor, sex hormones, and adipokines, and an elevated risk of prostate cancer in those who are obese or have a higher BMI. (3)

1.1.3 Clinical features of prostate cancer

Prostate cancer typically does not cause any noticeable symptoms in its early stages and is often detected incidentally during routine screening tests. However, if symptoms do occur, they typically manifest as lower urinary tract symptoms such as haematuria, urinary retention, incontinence, and flank pain. In more advanced stages of the disease, patients may experience fatigue, weight loss, loss of appetite, and if the cancer has spread to other parts of the body, bone pain and lymphedema may occur. (4)

1.1.4 Pathology and staging

The Gleason grading system is the standard to determine the stage of prostate cancer in patients. It works in conjunction with the TNM classification system to assess the risk of the disease and provide guidance on treatment options. To identify particular patterns, the search for histological specimens relies on the largest available sample size. A numerical scale ranging from 1 to 5 is used to indicate the level of aggressiveness, with the sum of the two most frequently observed patterns determining the calculated score in Gleason grading. This score ranges from 2 to 10. The TNM classification, on the other hand, refers to T, the primary tumor; N, the lymph nodes; and M, to the metastases. The T category in the TNM classification system helps determine the extent to which the surrounding tissue is involved and the level of tumor development. The primary tumor is divided into several subcategories, including TX, which indicates that no tumor can be detected, T0-T4, with T1-T3 further divided into a, b, and c. N refers to the involved lymph nodes in the surrounding tissues and M analyses regional and distant metastases. The fusion of these grading systems enables the development of a personalized treatment plan and an estimation of the patient's likelihood of survival. Consequently, clinical staging is a vital component in the management of prostate cancer. (5)

1.2 Diagnostic methods

For diagnosing prostate cancer there is no single, significant test. It relies on the digital rectal examination in combination with the measurement of PSA levels in Serum. The PSA is an organ-specific antigen for the prostate, but it is not considered to be cancer-specific.
Higher PSA levels increase the risk for prostate cancer. Increased values can be detected during a routine screening or if the patient has symptoms and prostate cancer is suspected. However, inflammation, manipulations of the prostate and benign prostate diseases can cause false-positive results of PSA levels measured. (4)(4)
The digital rectal examination is an important assessment for the prostate and has been the primary screening test for many years. In 1956 urologists began using DRE to detect changes in the prostate.
However, it is no longer recommended to use DRE as the sole test for prostate cancer detection because it may miss changes and lead to late diagnosis. Compared to PSA levels, relying solely on DRE for prostate cancer detection may result in poor prognoses for patients. (5)
One of the preferred methods for further evaluating suspected prostate cancer is transrectal ultrasonography with biopsy. Another effective technique is multiparametric MRI, which produces high-quality and three-dimensional images. This type of MRI can help guide prostate biopsies, provide insights in cases where there is clinical suspicion of prostate cancer despite a negative transrectal ultrasound with or without a biopsy, and aid in staging proven prostate cancer. CT, MRI or PET-CT and bone scintigraphy are established methods to identify cancer metastases, the involvement of local and distant lymph nodes and to detect if bone metastases have already occurred. (4)

1.3 Therapy

Therapeutic methods should be carefully evaluated for each patient and depend on several factors. It depends on the expected age of the patient, the cancer stage, as well as additional comorbidities. If a patient has a life expectancy of less than five years, extensive treatment options are typically not pursued. Regularly monitoring the patient´s PSA levels and performing DRE is recommended. Asymptomatic patients are therefore monitored, while symptomatic patients receive palliative care.
Radical prostatectomy or radiotherapy combined with ADT will be the method of choice in intermediate and high-risk patients.

Locally advanced prostate cancer is treated with a combination of ADT, androgen synthesis inhibitors, radiotherapy, and immunotherapy. (6) A similar procedure is also used for metastatic prostate cancer. Chemotherapy can be interchanged with ADT in those patients. Radical prostatectomy is a management option that may be considered for patients who cannot undergo active medical supervision.

It involves the surgical removal of the prostate gland and is more beneficial for prostate cancer patients under 65 years of age compared to older patients. (4)(4)

1.4 Aims and objectives

Over the years since the introduction of robotic-assisted radical prostatectomy, many advantages and limitations have been reported when comparing this technique to other surgical methods. In this paper there will be conducted an analysis of laparoscopic, robotic-assisted, and open radical prostatectomy, evaluating the effects of both laparoscopic and robotic-assisted techniques in comparison to open radical prostatectomy.

2. Literature Review

2.1 Predictors for complications

The assessment of risk factors is crucial in determining the appropriate surgical approach for radical prostatectomy. Baseline factors such as the patient's age, BMI, body size, smoker and previous diseases of the prostate should be taken into account when evaluating the potential for complications and selecting the most appropriate surgical procedure. (7)

Other factors, such as the patient's PSA level, Gleason score, and total prostate volume, are also important in determining the optimal course of action. In particular, the total prostate volume is a key consideration in selecting the surgical approach. Laparoscopic surgery may not be recommended if the prostate volume is too large due to poor visibility during the procedure. (8) Furthermore, the clinical and pathological tumor stage must be considered, as well as possible comorbidities of the patient, in order to plan the optimal further therapeutic procedure.

2.2 Intraoperative complications

Typical intraoperative complications of radical prostatectomy in general include bleeding, vascular injury, small bowel lesions, ureteral lesions, rectal lesions, nerve injuries, and positional damage. (9)

Vascular injury can occur in all of the three surgical procedures. In open radical prostatectomy, the Santorini plexus and other venous plexuses found in the pelvic floor could be injured. The risk of bleeding is greater if the nerves are spared since the surgeons may refrain from thermal coagulation.

Due to the creation of the pneumoperitoneum in robotic-assisted and laparoscopic procedures, vessels can be wounded when inserting the gas insufflation cannula, also known as the Veress needle, but even when introducing the trocar. If vessels are damaged perioperatively, hemorrhage is controlled using atraumatic forceps and absorbable material.

As with all surgical procedures, bleeding is a major risk factor. When comparing open surgery with robotic-assisted and laparoscopic surgery in various studies, it becomes clear that the patient's blood loss is considerably higher in the open radical prostatectomy procedure. If you look at a Swedish study from 2015, it becomes clear that between the open approach with 683 ml and 185 ml in the robotic-assisted approach the blood loss is significantly greater on average. In a 2010 study conducted in Sweden (10), a total of 1738 participants were analysed, out of which 170 individuals required a blood transfusion. Among these, 112 patients (23%) who underwent open prostatectomy required a transfusion, while only 58 patients (4.8%) who underwent robotic-assisted surgery required a transfusion.

Rectal lesions are not very common, but they can result in major complications. Factors such as a high Gleason score and tumor stage, as well as inexperienced surgeons, can contribute to the severity of these complications. Sometimes the prostate is attached to the anterior rectal wall due to previous prostatitis or inflammatory reaction after prostate biopsy, rather than progressed tumor stage. Injuries to the rectum arise after transection of Denonvilliers fascia or when dividing the last connections to the prostate. Early detection and treatment are crucial in managing this condition to prevent morbidity and mortality. The prevalence of ureter lesions depends on the surgical technique used. For example, the percentage for injuries during RARP is between 0.1% and 0.3%, while it is 0.8% during laparoscopic surgery and between 0.1% and 0.8% during open surgery.

Typically, ureter injuries are detected after the surgery has been completed. As mentioned earlier, entrapment, stretching, thermal injury, and transection lead to the most common nerve injuries.

During surgical procedures, there is a possibility that laparoscopic or robotic-assisted techniques may need to be switched to an open technique.

According to data collected from the NIS database between 2004 and 2010, this switch occurred in 1.8% of radical prostatectomy cases, often due to factors such as adhesions, anemia, a high BMI, and surgeon experience. Patients who require this conversion typically experience a higher rate of complications and a longer hospital stay.

Correct patient positioning is vital in all surgical procedures, including RARP. Unlike open prostatectomy, RARP requires the patient to lie in Trendelenburg position, which is less physically demanding.

However, when performing LRP or RARP, surgical teams must consider the potential risks associated with prolonged operative time, such as nerve injuries or compartment syndrome. (11)

2.3 Early postoperative complications

2.3.1 Clavien-Dindo Classification

The Clavien-Dindo classification (12) is a widely used system in surgery to categorize postoperative complications. It comprises of five subgroups, with subgroups 3 and 4 further divided into (a) and (b). Complications that fall under category 1-3a are considered minor, while 3b-5 are regarded as major complications.

Grade 1 complications involve deviations from the normal postoperative course, but without the need for surgical intervention. Grade 2 complications include the need for blood transfusions, parenteral nutrition, and intravenous administration of medication. Grade 3 involves surgical, endoscopic, and radiological interventions, without (a) or with (b) general anesthesia.

In cases where life-threatening complications arise, requiring intensive care intervention leading to single organ failure (a) or multiple organ failure (b), it is classified as grade 4 under the Clavien-Dindo classification. (12) Lastly, patient death is categorized as grade 5. (19)

2.3.2 Urinary dysfunctions

Urinary tract complications are a common issue after radical prostatectomy, including urinary tract infections, urinary retention, and strictures. A national cohort study conducted by Sujenthiran et al (13), between 2008 and 2012, examined the incidence of these complications within the first two years of surgery and compared three different surgical procedures. The study included 4947 men who underwent robotic-assisted radical prostatectomy, 5479 who had laparoscopic radical prostatectomy and 6873 who underwent open radical prostatectomy. Over time, the choice of surgical procedure changed considerably. At the beginning of the study, ORP was preferred in 61.3% of cases, while RARP was used in 24.8% and LRP in 14%. However, after five years, there was a significant decrease in the use of open surgery, with only 28.4% of patients still undergoing ORP. In contrast, LRP increased to 40.1% and RARP to 31.4%. This shows a noticeable change in the preference for surgical methods over time.

The study has revealed the effects of various surgical techniques on urinary complications. Within the first two years of surgery, an interference had to be performed in 10.5% of cases that used the robotic-assisted technique. In contrast, the percentage was higher for laparoscopic radical prostatectomy and open radical prostatectomy, with 15.8% and 19.1% respectively until 2019.

The findings suggest that men who undergo RARP have a lower incidence of complications compared to those who undergo LRP or ORP. Moreover, concerning the incidence of stricture-related complications, RARP demonstrated the lowest rate at 3.3%, compared to laparoscopic radical prostatectomy at 5.7%, and open radical prostatectomy at 6.9%. These results suggest that RARP not only has a lower overall incidence of complications but also demonstrates a lower incidence of stricture-related complications when compared to LRP and ORP. (13)

Several studies, Rechtmann et al. (14), Alessandro et al. (8), Luciani et al.(15) (15), and Stolzenburg et al. (7), have focused on continence after radical prostatectomies, with patients typically completing questionnaires and being followed up at 3, 6, and 12 months after surgery. Comparing the continence rates across four different studies and surgical procedures, it is evident that two of the three studies measuring the 12-month period did not find significant differences among surgical techniques, while one did.

Two of the four studies also compared values at 3 and 6 months post-operatively, and both studies arrived at the same conclusion.

The studies conducted by Rechtman et al. (14) and Alessandro et al. (8) both show no significant difference in continence rates after 12 months of follow-up. In contrast, Luciani et al. (15) present a clear differentiation between surgical techniques. After one year, the continence rate for patients undergoing RARP was 80%, for LRP patients it was 72%, and for patients undergoing open surgery it was 68%. (15;14)

Additionally, Alessandro et al. (8) examined not only continence rates between LRP and ORP after 12 months, but also after 3 and 6 months. After 3 months, the proportion between LRP and ORP was 88.9% and 75.7%, and after 6 months it was 92.6% and 87.8%. This indicates that better results can be achieved through the selection of laparoscopic procedures in a short period of time. (8)

In another study, Stolzenburg et al. (7) analyzed the continence rates between RARP and LRP. They looked at a total of 622 patients, of whom 511 underwent RARP and 111 underwent LRP. After 3 months, continence improved in 54% of RARP patients and 46% of LRP patients, pads and safety use was no longer needed. The measures of this study stated that an individual who underwent RARP had a likelihood ranging from 56% to 58% of experiencing reduced pad usage, decreased urine leakage, lower leakage volume, and less disruption in daily activities due to incontinence compared to an LRP patient. The bilateral nerve-sparing technique also showed a significant discrepancy between RARP at 66% and LRP at 50%. (7) When considering the mental aspect of incontinence, most patients experience stress incontinence rather than the urgency type.

They suffer from uncontrollable urine loss under stress, which can lead to depression, shame, a diminished self-image, and social isolation. Incontinence is a burden for patients and greatly limits their daily lives. Therefore, it is important to determine the best surgical approach on an individual basis. (16)

2.3.3 Erectile dysfunction

During a radical prostatectomy, injury to the vessel-nerve-bundle that supplies the corporus cavernosus can result in a lack of oxygenation leading to apoptosis of smooth muscle tissue. This can cause an increase in collagen fibers and fibrosis of the corpus cavernosum, which reduces the tissue's elasticity and limits erectile function. Patients may experience a reduced quality of life and strained relationships as a result. To aid in penile rehabilitation, phosphodiesterase-5 inhibitors such as Sildenafil can be used.

Erectile dysfunction can result from various factors, including age, chronic medical conditions, and preoperative erectile function, and recovery of potency can take up to 40 months after the operation. (16)

Stolzenburg et al. (7) compared the potency recovery rates of patients who underwent RARP and LRP procedures. Three months' post-operation, RARP patients showed 18% potency recovery compared to only 6.7% in LRP patients. Additionally, uni- or bilateral nerve sparing techniques during surgery can enhance recovery of erectile dysfunction. (7) After 12 months, the potency recovery rates for LRP and open approaches were found to be 52.9% and 45%, respectively. (8)

Furthermore, RARP was shown to decrease the odds of erectile dysfunction by more than 40% compared to LRP. (10)

2.3.4 Hospital Stay

The duration of hospital stays is gaining economic significance in contemporary times, particularly for radical prostatectomy procedures. A study conducted in Germany in 2004 reported that the hospitalization period for patients who underwent open surgery was 11.2 days, while those who underwent laparoscopic surgery had a hospitalization period of 12.4 days. (17)

In a European study conducted in 2010, minimal variations were observed in the hospitalization period for different surgical approaches.

The shortest duration was observed in RARP with 7.8 days, followed by LRP with 8.4 days, and the open procedure taking nearly 10 days. (10) However, in a more recent study conducted in 2016, the duration of hospitalization has been further reduced.

The open approach still has the longest duration of 5.54±1.41 days, while LRP has a hospitalization period of 4.35±5.54 days. (8)

Surgical techniques for radical prostatectomy have advanced significantly over the years, leading to a notable decrease in hospitalization periods for patients. In 2004, patients typically required hospital stays of more than 10 days following surgery. However, 12 years later, patients are often discharged after only 5-6 days due to these innovative advancements.

2.3.5 Postoperative Pain

The 2010 European study evaluated postoperative pain levels across different surgical approaches for radical prostatectomy. The study included 315 patients who underwent the open procedure, 276 who underwent LRP, and 816 who underwent RARP.

At one day post-surgery, 36.1% of ORP patients reported moderate pain, while 63.3% reported severe pain. In contrast, 30.6% of RARP patients reported moderate pain, and 55.9% reported severe pain. Patients who underwent LRP reported intermediate levels of pain severity.

However, the differences between the techniques became more apparent after the first day post-surgery. One week later, the percentage of patients experiencing severe pain was only slightly different across the groups. In the ORP group, 26% still reported moderate pain, while 43.8% reported severe pain. Among RARP patients, 20% reported moderate pain, while 41.9% reported severe pain. Interestingly, the percentage of patients reporting severe pain was highest in the LRP group, both one day and one-week post-surgery. At the 12-week mark, the percentage of patients reporting moderate pain was highest among LRP patients at 5.1%, followed by 3.2% in ORP patients and 2.1% in RARP patients. None of the patients complained about severe pain 12 weeks postoperatively. (10)

2.3.6 Blood loss and transfusions

A comparative analysis conducted in 2017 at a single regional center compared surgical outcomes among three different surgical techniques. Each technique was used to operate on 100 patients.

The results showed that patients who underwent ORP and LRP had significantly higher blood loss at 600ml compared to the RARP group, which had a blood loss of 400ml. Consequently, the transfusion rate was 21% and higher for ORP and LRP patients compared to 6% for RARP patients. (8)

A smaller study conducted in 2016 showed similar results, with LRP patients experiencing a blood loss of 366.67±142.75ml and ORP patients experiencing a blood loss of 572.73±174.13ml. The transfusion rate was 7.4% for LRP patients and 27.3% for ORP patients. (10)

And, other Studies have indicated that RARP and LRP procedures result in significantly less blood loss and a lower need for transfusions compared to ORP. Due to better visualization and thus dissection of the tissues. (9)

2.3.7 Operation time

While minimally invasive procedures have positive advantages in most cases, they lag the open method in surgical time and take significantly longer. Two studies, conducted in 2006 and 2016 respectively, compared the time needed for open surgery and laparoscopic surgery. The average surgical time for open surgery was found to be 170±34 minutes and 152.28±27.44 minutes, respectively. The time for LRP was much higher with 235±49 minutes and 188.51±27.50 minutes. (18;8)

In a more recent study from 2022, a European research team examined 1742 articles on perioperative outcomes and complications between 2000 and 2020 from eight databases. The study found that the average surgical time for open surgery was 169.53 minutes, laparoscopic surgery required 214.92 minutes, and robotic-assisted surgery took 199.78 minutes on average. (19)

2.3.8 Prostate specific survival

According to a 2019 meta-analysis and systematic review conducted by Cao et al (20), there appears to be no significant difference in the rate of positive surgical margins between LRP/RARP and ORP. The review found that 22.3% of LRP/RARP patients had positive surgical margins, while the rate for ORP was slightly higher at 28.6%. However, when positive surgical margins were analyzed based on tumor staging, there were differences between the techniques. For tumors below stage T2, the rate of positive surgical margins was similar for all three techniques, at 14.7%. But for tumors at stage T3 and above, LRP/RARP had a rate of 41.4%, while ORP had a rate of 50.1%, indicating a greater likelihood of positive surgical margins with larger tumors. Overall, these findings suggest that the difference in positive surgical margins between LRP/RARP and ORP is not significant, but the likelihood of positive margins is affected by tumor stage. (20)

In a study conducted by Alessandro et al. in 2016 (8), it was found that there was no significant difference between LRP/RARP and ORP in terms of the percentage and number of positive cutting edges. The study found that these factors were similar in both techniques, as well as in relation to preoperative prostate-specific antigen levels, pathological T stage, and Gleason score. These findings suggest that LRP/RARP and ORP may be similarly effective in achieving negative surgical margins. (8)

3. Discussion

Over two decades ago, the Da Vinci robot was introduced into surgical practice and has since gained increasing popularity. Although the da Vinci Surgical System is being used in many hospitals, there is still room for expansion. In the United States, approximately 65% of hospitals use the robot, while in Europe, only 17% do so. One of the primary reasons for this is the cost of the system, in addition to the fact that its benefits over other surgical techniques are not significant enough. Due to limited funds, the da Vinci Surgical System is still not accessible for most small clinics. As a result, the open method and laparoscopy are preferred options, as they are significantly more cost-effective.

In spite of this, the robot provides advantages such as smaller incisions, reduced risk of infection, and a 3D view for a better overview of small vessels and nerves, which minimizes the risk of bleeding and other intraoperative injuries. However, the da Vinci is not an autonomous device, and it requires specialized training to operate. Its seven degrees of freedom enable it to perform with greater precision than a human surgeon, reducing the risk of tremors and preventing back pain by requiring less force. In addition, the operation requires only 2 people, the surgeon and the person who is with the patient. This reduces the cost of personnel. Nevertheless, operating times are longer, and there is additional effort required for the thorough cleaning of the robot's instruments.

Laparoscopy has also become a standard procedure for a wide range of operations, making these two techniques a preferred alternative to open surgery. In the past 20 years, three different surgical techniques for radical prostatectomy have been compared to determine the best possible procedure for patients and surgeons. The focus of these analyses has been on peri- and postoperative complications, with most studies comparing urinary dysfunction, hospital stay, blood loss and transfusion, and operation time. Due to the fact minimally, invasive techniques offer better visualization of tissues and safer dissection one might think that RARP and LRP offer better results than ORP in every point. It is crucial to acknowledge the learning curves and the surgeon's experience when evaluating surgical techniques. Older colleagues are particularly skilled in performing open surgeries with high precision, and therefore, they often favour this method over others. However, it is worth noting that the learning curve for open procedures is steeper compared to the da Vinci or laparoscopy. Despite the availability of modern technologies, open procedures are still considered a safe and reliable option.

As a result of better visibility, typical intraoperative complications such as significant bleeding, vascular injuries, small bowel lesions, ureteral lesions, and nerve injuries can be avoided or reduced with minimally invasive techniques. However, new potential complications should be considered, such as the formation of the intended pneumoperitoneum, which would not typically occur in an open surgery. In addition, the surgeon's inexperience, and predictors such as an increased BMI, significantly enlarged prostate, or advanced age of the patient can lead to various complications.

Although some studies have found no significant differences between the surgical techniques, others have identified variations in postoperative complications.

However, the studies have consistently shown almost similar results regarding urinary incontinence and strictures. Some studies, such as those conducted by Sujenthiran et al. (13) and Luciani et al. (15), have shown clear advantages of robotic-assisted radical prostatectomy over the other two techniques. (21)

Alessandro et al. (8), on the other hand, did not find any differences after a 12-month period, but noted better results within 3-6 months compared to open surgery.

Erectile dysfunction is one of the most significant complications from the patient's perspective, and it is best to use nerve-sparing techniques to achieve the fastest possible recovery of function. Among the available techniques, RARP has been shown to produce the best results, especially when compared to LRP. While the differences in outcomes between LRP and ORP are minimal after 12 months, significantly better results have been achieved with the da Vinci system in as little as three months when comparing RARP and LRP. From an economic perspective, the length of hospital stays for patients has become increasingly important. A study from 2004 and 2006 (17;18;22) found that patients stayed in the hospital for approximately 11 days after open surgery and 12 days after minimally invasive procedures. However, in a more recent 2016 study (8), hospital stays were slightly reduced after open surgery compared to minimally invasive procedures. Nowadays, patients are typically only hospitalized for a maximum of 5 to 6 days, indicating a continuous development of surgical techniques and a reduction in associated complications. The lack of available data highlights the limited study outcomes regarding the same complications when comparing all three or just two of the surgical techniques. Different outcomes can be observed even when multiple studies investigate the same complication using the same surgical technique. (23)

Hospitals tend to have varied approaches to surgical techniques, with some having access to the da Vinci Surgical System but using it rarely or not at all due to a lack of experience. Additionally, the at the beginning believed relatively small differences in complications between different surgical techniques may be a factor that makes surgeons more inclined to utilize the da Vinci. By introducing mandatory workshops, this problem could be countered, and surgeons could master multiple surgical techniques and apply them more individually to the patient.

4. Conclusion

There are several ways to conduct a prostate cancer surgery, including the open, laparoscopic, and robotic-assisted techniques.

The goal of this study was to compare these three approaches and determine which technique results in the fewest complications for prostate cancer patients. After analysing multiple studies conducted in Europe and beyond over a 20-year period, the researchers concluded that all three surgical techniques are generally safe and that the differences between them, particularly between open and robotic-assisted procedures, were not that significant, initially. However, they have become significant over time, especially in terms of erectile dysfunction, potency and prostate cancer – specific mortality. Robotic-assisted radical prostatectomy was found to have moderately fewer complications and more advantages, but its limitations should also be taken into consideration. Overall, the study suggests that the open approach has the highest rate of complications, while laparoscopy provides a satisfactory balance as a minimally invasive technique with lower rates of complications. The da Vinci robot, although offering advanced technology, comes with high acquisition costs and requires a significant learning curve for operators, making it a more limited option. More efforts should be made in the coming years to make minimally invasive surgical techniques even more attractive to surgeons, and studies should be updated to determine if more clinics are adopting modern technology and to further reduce complication rates.

5. Summary

This research analysed peri- and post-operative complications following prostate resection and compared three different surgical approaches. It extended the traditional open approach and two minimally invasive techniques, laparoscopy, and the Vinci robotic surgery, were examined.

The most common complications, such as urinary dysfunction, erectile dysfunction, blood loss, transfusion rates, postoperative pain, hospital stay, and operation time were of particular interest. Many different studies, Rechtmann et al. (14), Luciani et al. (15), Wang et al. (6), spanning 18 years were analysed to compare these complications and the different surgical techniques.

The analysis revealed differences between the surgical approaches, especially in urinary dysfunction, erectile dysfunction, blood loss and transfusion rates, which demonstrated the da Vinci robot as a modern, advanced technique in comparison with the other two in which laparoscopy showed better results than the open approach. There were only slight differences between the techniques in terms of hospital stay.

The robotic-assisted technique resulted in a shorter hospital stay compared to laparoscopy and the open approach, which only showed a slightly prolonged stay of about one day. The open approach is only superior in terms of the operation time followed by robotic-assisted and laparoscopy, respectively. However, the use of the da Vinci robot also has its limitations but with a new robotic device, it could become the best technology for radical prostatectomy.

6. References

(1) Rawla P. Epidemiology of Prostate Cancer. World J Oncol. 2019 Apr;10(2):63-89. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6497009/

(2) Prostate Cancer [Internet]. Next.amboss.com. [updated March 6, 2023; accessed March 26, 2023]. Available from: https://next.amboss.com/us/article/Ji0ssf

(3) Ng KL. The Etiology of Prostate Cancer. In: Bott SRJ, Ng KL, editors. Prostate Cancer [Internet]. Brisbane (AU): Exon Publications; 2021 May 27. Chapter 2. Available from:https://www.ncbi.nlm.nih.gov/books/NBK571322/doi:10.36255/exonpublications.prostatecancer.etiology.2021

(4) Prostate Cancer [Internet]. Next.amboss.com. [updated March 6, 2023; accessed March 26, 2023]. Available from: https://next.amboss.com/us/article/Ji0ssf

(5) Borley N, Feneley MR. Prostate cancer: diagnosis and staging. Asian J Androl. 2009 Jan;11(1):74-80. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3735216/

(6) Ian Wang; Lianku Song; Beverly Y Wang et all: Am J Clin Exp Urol. 2022; 10(4): 210–233. Published online 2022 Aug 15. Prostate cancer immunotherapy: a review of recent advancements with novel treatment methods and efficacy

(7) Stolzenburg J, Holze S, Neuhaus P, Kyriazis I, Do HM, Dietel A, et al. Robotic-assisted Versus Laparoscopic Surgery: Outcomes from the First Multicentre, Randomised, Patient-blinded Controlled Trial in Radical Prostatectomy (LAP-01). European Urology. 2021 Jun;79(6):750-9. Available from: https://www.uniklinikum-leipzig.de/einrichtungen/zrnc/Freigegebene%20Dokumente/Publikationen/Stolzenburg_Holze_Eur%20Urol_2021.pdf

(8) Alessandro S, Alessandro G, Susanna C, Michele I, Francesca DQ, Andrea F, et al. Laparoscopic versus open radical prostatectomy in high prostate volume cases: impact on oncological and functional results. Int Braz J Urol. 2016;42(2):223-33. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4871381/

(9) Zugor V, Poth S, Addali M, Eck A,Witt JH, Labanaris AP. Intra- und postoperative Komplikationen bei Patienten mit roboterassistierter laparoskopischer radikaler Prostatektomie (RALP). Eine Analyse von 3000 konsekutiven Fällen. Journal für Urologie und Urogynäkologie. 2012 (accessed March 10, 2023); 19(3):10-14. Available from: https://www.kup.at/kup/pdf/10926.pdf

(10) Hruza M, Weiß HO, Pini G, Goezen AS, Schulze M, Teber D, et al. Complications in 2200 Consecutive Laparoscopic Radical Prostatectomies: Standardised Evaluation and Analysis of Learning Curves. European Urology. 2010 Nov;58(5):733-41. Available from: https://www.sciencedirect.com/science/article/pii/S0302283810007554

(11) Haidl F, Al-Monajjed R. Prostatakarzinom – chirurgische Komplikationen. Aktuelle Urol. 2020 Sep;51(05):469-74. Available from: https://www.thieme-connect.com/products/ejournals/pdf/10.1055/a-1185-8179.pdf

(12) AssesSurgery GmbH (no date) *The clavien-dindo classification*, *AssesSurgery GmbH*. Available at: https://www.assessurgery.com/clavien-dindo-classification/ (Accessed: 28 May 2023).

(13) Sujenthiran A, Nossiter J, Parry M, Charman SC, Aggarwal A, Payne H, et al. National cohort study comparing severe medium-term urinary complications after robot-assisted vs laparoscopic vs retropubic open radical prostatectomy. BJU Int. 2018 Mar;121(3):445-52.Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5873443/

(14) Rechtman, M., Forbes, A., Millar, J.L. *et al.* Comparison of urinary and sexual patient-reported outcomes between open radical prostatectomy and robot-assisted radical prostatectomy: a propensity score matched, population-based study in Victoria. *BMC Urol* **22**, 18 (2022). https://doi.org/10.1186/s12894-022-00966-0

(15) Luciani LG, Mattevi D, Mantovani W, Cai T, Chiodini S, Vattovani V, et al. Retropubic, Laparoscopic, and Robot-Assisted Radical Prostatectomy: A Comparative Analysis of the Surgical Outcomes in a Single Regional Center. Current Urology. 2017 Nov;11(1):36-41. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5814781/

(16) Kutteroff, N.F. (1970) *Peri- und postoperative Komplikationen und outcome nach Radikaler Retropubischer Prostatektomie in Abhängigkeit von Prostatavolumen und benignen prostatasymptomen*, *mediaTUM*. Available from https://mediatum.ub.tum.de/?id=1340111 (Accessed: March 20, 2023

(17) Fornara P, Zacharias M. Minimale Invasivität der laparoskopischen radikalen Prostatektomie: Wirklichkeit oder Wunsch?. Aktuel Urol. 2004 Sep;35(5):395-405. Available from: https://pubmed.ncbi.nlm.nih.gov/15368129/

(18) Rassweiler J. Open vs. Laparoscopic Radical Prostatectomy… and Laparoscopy is Better!. European Urology. 2006 Jul;50(1):26-8. Available from: https://www.europeanurology.com/article/S0302-2838(06)00337-X/fulltext

(19) Moretti TBC, Magna LA, Reis LO. Surgical Results and Complications for Open, Laparoscopic, and Robot-assisted Radical Prostatectomy: A Reverse Systematic Review. Eur Urol Open Sci. 2022 Oct;44:150-61. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9468352/

(20) Cao L, Yang Z, Qi L, Chen M. Robot-assisted and laparoscopic vs open radical prostatectomy in clinically localized prostate cancer: perioperative, functional, and oncological outcomes. Medicine. 2019 May;98(22):e15770. Available from: https://www.researchgate.net/publication/333483699_Robot-assisted_and_laparoscopic_vs_open_radical_prostatectomy_in_clinically_localized_prostate_cancer_perioperative_functional_and_oncological_outcomes

(21) Rechtman, M., Forbes, A., Millar, J.L. *et al.* Comparison of urinary and sexual patient-reported outcomes between open radical prostatectomy and robot-assisted radical prostatectomy: a propensity score matched, population-based study in Victoria. *BMC Urol* **22**, 18 (2022). https://doi.org/10.1186/s12894-022-00966-0

(22) Hegarty NJ, Kaouk JH. Radical prostatectomy: a comparison of open, laparoscopic and robot-assisted laparoscopic techniques. Can J Urol. 2006 Feb;13 Suppl 1:56-61. https://pubmed.ncbi.nlm.nih.gov/16526984/

(23) Eva Haglind a, *, Stefan Carlsson b, Johan Strannec, et all. Urinary Incontinence and Erectile Dysfunction After Robotic Versus Open Radical Prostatectomy: A Prospective, Controlled, Nonrandomised Trial. European Urology. 2015 Feb;25:216-225

7. CV

Louisa Haupt was born in Schoenebeck on June 5th, 1999. She is a diligent and hard-working individual who is currently pursuing a medical degree at the Medical Faculty in Rijeka, Croatia, which she began in October 2017.

Prior to her medical studies, Louisa Haupt completed her Abitur at Dr. Carl-Herman-Gymnasium from August 2008 to June 2017.

In addition to her studies, she has gained practical experience through internships in various medical fields and worked in a corona centre during the pandemics.

In addition to their academic achievements, she is also fluent in English with a C2 proficiency level and proficient in Croatian with a B1 proficiency level.

Overall, Louisa Haupt is a dedicated and committed individual with a strong academic background and language skills by which she can contribute significantly to any professional setting.