DOI: https://doi.org/10.61841/9vwe2n13 Publication URL: https://nnpub.org/index.php/MHS/article/view/2228

COMPARISON OF ROBOTIC RADICAL PROSTATECTOMY VS LAPAROSCOPIC RADICAL PROSTATECTOMY ON PROSTATE CANCER PATIENT: A COMPREHENSIVE SYSTEMATIC REVIEW

[*1]M. Iqbal Rifai Fauzi, [1]Karina Asysyifaa Alemina Ramadhani Ginting

[1]Faculty of Medicine, Muhammadiyah University of North Sumatera, Indonesia

Corresponding Author:
rifaiqbal008@gmail.com

ABSTRACT

Background: *Prostate cancer constitutes 3.8% of all cancer-related deaths in men. Radical prostatectomy stands as a standard surgical treatment for prostate cancer. Robot-assisted systems have emerged aiming to simplify the intricacies of complex laparoscopic procedures. Specifically, robot-assisted laparoscopic prostatectomy (RALP) has been proposed as a means to expedite the learning curve, potentially leading to quicker reductions in operative time compared to traditional laparoscopic techniques (LRP). This study aims to serve a comprehensive systematic review to compare laparoscopic radical prostatectomy (LRP) and robot-assisted laparoscopic prostatectomy (RALP) on prostate cancer based on literatures of the last 10 years.*

Methods: *The review adhered to PRISMA 2020 standards and analyzed full-text English literature from 2014 to 2024. It excluded editorials, review papers from the same journal, and submissions lacking a DOI. Literature sources included PubMed, SagePub, SpringerLink, and Google Scholar.*

Result: *A total of 655 articles were retrieved from online databases (PubMed, SagePub, SpringerLink and Google Scholar). After three rounds of screening, five articles directly relevant to the systematic review were selected for full-text reading and analysis.*

Conclusion: *Robot-assisted radical prostatectomy (RARP) offers advantages such as quicker recovery and comparable safety to laparoscopic radical prostatectomy (LRP). Studies show better urinary continence and potency outcomes with RARP. While PSM rates vary between RARP and LRP, further research is needed to understand their impact on recurrence. Despite challenges like the lack of tactile sensation in RARP, it remains a popular choice for prostate cancer treatment.*

Keyword: *Laparoscopic radical prostatectomy, Robot-assisted radical prostatectomy, Oncological outcome*

INTRODUCTION

Prostate cancer ranks as the second most common cancer in men globally. In 2017, around 160,000 men were diagnosed, contributing to a total of 3.3 million survivors. GLOBOCAN 2018 reported 1,276,106 new cases, resulting in 358,989 deaths. Prostate cancer constitutes 3.8% of all cancer-related deaths in men.[1] Initially, it often presents no symptoms and progresses slowly with minimal or no treatment needed. However, symptoms like urination difficulties, increased frequency, and nocturia may occur, resembling prostatic hypertrophy. Advanced stages may show urinary retention and back pain, especially as bony metastases develop in the axial skeleton.[2]

Prostate cancer incidence and mortality are closely linked to advancing age, with an average diagnosis age of 66. African-American men have higher incidence rates compared to White men, with a mortality rate approximately double that of White men. Various risk factors such as genetic predisposition, family history, and race/ethnicity contribute to its development. Individual, environmental, and occupational factors also play a role in epidemiological variations. Disparities stem from social, environmental, and genetic factors. By 2040, an estimated 2,293,818 new cases are projected, with a minimal increase in mortality (1.05%) expected.[3]

For men diagnosed with localized prostate cancer, the range of treatment options offers both reassurance and complexity. Beyond surgical intervention, men diagnosed with localized prostate cancer have alternatives such as active surveillance, radiation therapy, and hormone therapy. Active surveillance, also known as watchful waiting, involves closely monitoring the cancer's progression without immediate aggressive treatment, which can be suitable for low-risk cases or for those with limited life expectancy. Radiation therapy, whether external beam or brachytherapy, utilizes high-energy rays to target and destroy cancer cells, while hormone therapy aims to reduce testosterone levels or block its effects to slow cancer growth. These treatment modalities offer personalized approaches based on factors such as cancer stage, aggressiveness, and individual patient preferences.[4]

Radical prostatectomy stands as a standard surgical treatment for prostate cancer. This procedure can be conducted through various approaches, including open surgery, laparoscopic techniques (LRP), or the increasingly popular robotic-assisted laparoscopic approach (RALP). While radical prostatectomy offers a definitive treatment, it also poses potential risks and side effects, such as urinary incontinence and erectile dysfunction. However, advancements in surgical techniques and technology have aimed to mitigate these concerns, with newer approaches like robot-assisted procedures demonstrating promise in reducing postoperative complications and enhancing recovery times.[5]

Robot-assisted systems have emerged aiming to simplify the intricacies of complex laparoscopic procedures. Specifically, robot-assisted laparoscopic prostatectomy (RALP) has been proposed as a means to expedite the learning curve, potentially leading to quicker reductions in operative time compared to traditional laparoscopic techniques (LRP). However, despite these claims, several systematic reviews of observational studies have failed to demonstrate significant disparities between the two methods. Variables such as operative time, urinary continence, erectile function, blood loss, and positive margin rates have all shown statistically insignificant differences. The reliance on observational studies has highlighted methodological limitations, prompting calls for prospective, comparative studies to provide more conclusive evidence regarding the comparative effectiveness of RALP versus LRP in prostate cancer treatment.[6] This study aims to serve a comprehensive systematic review to compare laparoscopic radical prostatectomy (LRP) and robot-assisted laparoscopic prostatectomy (RALP) on prostate cancer based on literatures of the last 10 years.

METHODS

Protocol

The author carefully followed the rules laid out in the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020. This was done to make sure the study met all its standards. The selection of this methodological approach was specifically aimed at ensuring the precision and reliability of the conclusions drawn from the investigation.

Criteria for Eligibility

This systematic review compared laparoscopic radical prostatectomy (LRP) and robot-assisted laparoscopic prostatectomy (RALP) on prostate cancer based on literatures of the last 10 years. This study meticulously analyzed data on literatures to provide insights and enhance patient treatment strategies. The primary objective of this paper is to highlight the collective significance of the identified key points.

Inclusion criteria for this study entail: 1) Papers must be in English, and 2) Papers must have been published between 2014 and 2024. Exclusion criteria comprise: 1) Editorials; 2) Submissions without a DOI; 3) Previously published review articles; and 4) Duplicate entries in journals.

Search Strategy

The keywords used for this research are “Laparoscopic radical prostatectomy”, “Robot-assisted radical prostatectomy”, and “Oncological outcome”. The Boolean MeSH keywords inputted on databases for this research are: *(("laparoscopes"[MeSH Terms] OR "laparoscopes"[All Fields] OR "laparoscope"[All Fields] OR "laparoscopical"[All Fields] OR "laparoscopically"[All Fields] OR "laparoscopics"[All Fields] OR "laparoscopy"[MeSH Terms] OR "laparoscopy"[All Fields] OR "laparoscopic"[All Fields]) AND ("radical"[All Fields] OR "radical s"[All Fields] OR "radicals"[All Fields]) AND ("prostatectomy"[MeSH Terms] OR "prostatectomy"[All Fields] OR "prostatectomies"[All Fields]) AND ("Robot-assisted"[All Fields] AND ("radical"[All Fields] OR "radical s"[All Fields] OR "radicals"[All Fields]) AND ("prostatectomy"[MeSH Terms] OR "prostatectomy"[All Fields] OR "prostatectomies"[All Fields])) AND (("oncologic"[All Fields] OR "oncological"[All Fields] OR "oncologically"[All Fields] OR "oncologics"[All Fields]) AND ("outcome"[All Fields] OR "outcomes"[All Fields]))) AND (y_10[Filter])*

Data retrieval

The authors assessed the studies by reviewing their abstracts and titles to determine their eligibility, selecting relevant ones based on their adherence to the inclusion criteria, which aligned with the article's objectives. A consistent trend observed across multiple studies led to a conclusive result. The chosen submissions had to meet the eligibility criteria of being in English and a full-text.

This systematic review exclusively incorporated literature that met all predefined inclusion criteria and directly pertained to the investigated topic. Studies failing to meet these criteria were systematically excluded, and their findings were not considered. Subsequent analysis examined various details uncovered during the research process, including titles, authors, publication dates, locations, study methodologies, and parameters.

Quality Assessment and Data Synthesis

Each author independently evaluated the research presented in the title and abstract of the publication to determine which ones merited further exploration. The subsequent stage involved assessing all articles that met the predefined criteria for inclusion in the review. Decisions on including articles in the review were based on the findings uncovered during this evaluation process. This criterion aimed to streamline the paper selection process for further assessment, facilitating a comprehensive discussion of previous investigations and the factors that made them suitable for inclusion in the review.

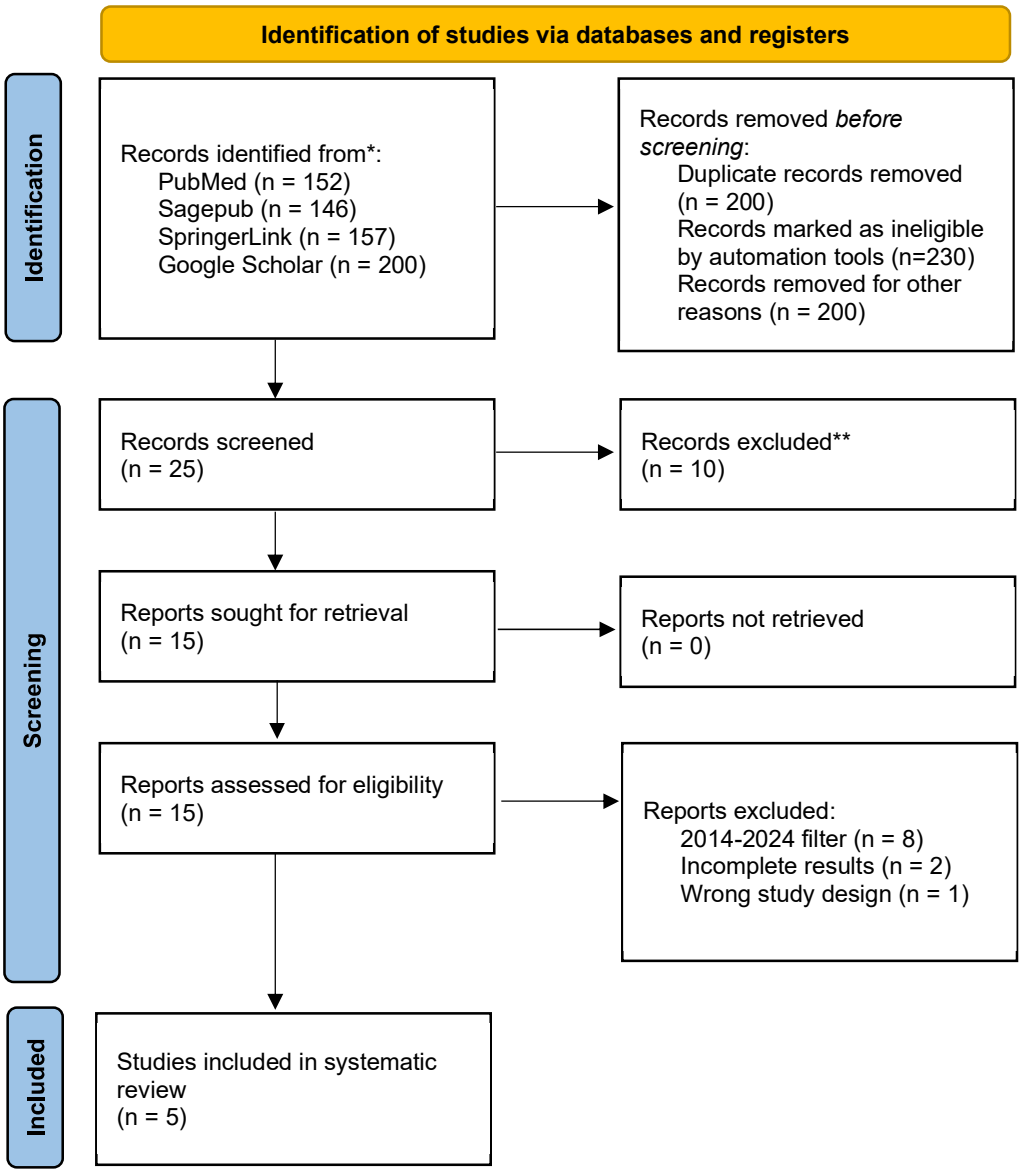

Figure 1. Article search flowchart

RESULT

The initial number of articles retrieved from online databases (PubMed, SagePub, SpringerLink, and Google Scholar) is 655 articles. After conducting three levels of screening, five articles that directly relate to the current systematic review have been chosen for further assessment through full-text reading and analysis. Table 1 presents the selected literature included in this analysis.

Table 1. The literature included in this study

Author	Origin	Method	Sample	Result
Porpiglia, et al.[7] (2018)	Italy	Prospective randomised controlled trial	120 prostate cancer patients	A prospective randomized study conducted from January 2010 to January 2011 enrolled 120 patients with organ-confined prostate cancer, randomly assigning them to either RARP or LRP. A single surgeon performed all

				procedures using the same technique. Five-year outcomes were assessed, with continence, potency, serum prostate-specific antigen levels, patient satisfaction, and oncologic outcomes analyzed. Results revealed that RARP significantly improved continence and potency over time compared to LRP, without compromising patient survival or oncologic outcomes. Pathologic factors such as Gleason score, surgical margins, and tumor stage were associated with higher biochemical recurrence rates. Patient satisfaction and general health status were notably higher in the RARP group.
Okegawa, et al.[8] (2020)	Japan	Retrospective study	700 prostate cancer patients	The study aimed to assess the pathological and oncological outcomes of laparoscopic radical prostatectomy (LRP) versus robot-assisted radical prostatectomy (RARP) performed by a single surgeon at one center. The analysis included 700 patients with localized prostate cancer, of which 250 underwent LRP and 450 underwent RARP. Results showed that patients in the RARP group had a lower overall positive surgical margin (PSM) rate compared to those in the LRP group, particularly in cases of more advanced disease stages (pT2c, pT3a, and pT3b). Additionally, multivariate analysis indicated that RARP reduced the risk of biochemical recurrence (BCR). Notably, among D'Amico high-risk

				patients, RARP demonstrated a significantly higher rate of BCR-free survival compared to LRP. These findings suggest that RARP may offer improved oncological outcomes, particularly in high-risk prostate cancer cases, compared to LRP in this single-center study.
Stolzenburg, et al.[9] (2022)	Germany	Randomized controlled trial	701 prostate cancer patients	This multicenter, randomized, patient-blinded controlled trial compared the continence, potency, and oncological outcomes between RARP and LRP over a 12-month follow-up period. Patients referred for radical prostatectomy to four hospitals in Germany were randomly assigned to either RARP or LRP. Continence, potency, and oncological outcomes were assessed using validated questionnaires and statistical analysis methods. Results showed that while continence at 6 and 12 months post-surgery was better in RARP patients, the difference was not statistically significant. However, patients who were potent at baseline and underwent nerve-sparing surgery reported significantly higher potency after RARP at 3, 6, and 12 months. There were no significant differences in oncological outcomes at the 12-month mark.
Lee, et al.[10] (2015)	Korea	Retrospective study	356 high risk prostate cancer patients	A comparative analysis was conducted on high-risk prostate cancer (PCa) patients who underwent either robotic-assisted radical prostatectomy (RARP) or traditional retropubic

				radical prostatectomy (RRP) by a single surgeon between 2007 and 2013. High-risk PCa was defined as clinical stage ≥ T3a, biopsy Gleason score of 8–10, or prostate-specific antigen > 20 ng/mL. Propensity score matching was utilized to minimize selection bias, ensuring preoperative and postoperative confounders were balanced between groups. The study included 356 high-risk PCa patients, with 106 (29.8%) undergoing RRP and 250 (70.2%) undergoing RARP. Before adjustment, RRP patients exhibited poorer mean percentage of positive cores on biopsy and pathologic stage compared to RARP. Unadjusted 5-year biochemical recurrence-free survival (BCRFS) rates favored RARP over RRP, but after adjustment for preoperative variables, the BCRFS rates were similar between the two groups.
Tozawa, et al.[11] (2014)	Japan	Retrospective cohort study	708 patients with localized prostate cancer	A comparison was conducted between laparoscopic radical prostatectomy (LRP) and robot-assisted radical prostatectomy (RARP), focusing on surgical outcomes and the occurrence and locations of positive surgical margins (PSMs). The study included 708 male patients with clinically localized prostate cancer, with 551 undergoing LRP and 157 undergoing RARP between January 1999 and September 2012. Parameters such as operative time, blood loss, complications, and

				PSM frequency were analyzed. While there were no significant differences in age or body mass index between LRP and RARP patients, RARP patients had higher prostate-specific antigen levels, Gleason sum, and clinical stage. RARP patients experienced significantly less bleeding. The overall frequency of PSMs was 30.6% in the LRP group and 27.5% in the RARP group, with notable differences in PSM distribution between the two approaches. In LRP, PSMs were predominantly found in the apex, anterior, posterior, lateral regions of the prostate, and bladder neck, whereas in RARP, PSMs were distributed similarly but with variations in frequencies.

Porpiglia, et al.[7] (2018) found that RARP offers superior functional outcomes compared to LRP while maintaining comparable oncologic efficacy over a five-year period.

Okegawa, et al.[8] (2020) in their single-center study supported this result and showed that RARP may offer improved oncological outcomes, particularly in high-risk prostate cancer cases compared to LRP. patients in the RARP group had a lower overall positive surgical margin (PSM) rate compared to those in the LRP group, particularly in cases of more advanced disease stages (pT2c, pT3a, and pT3b). Additionally, multivariate analysis indicated that RARP reduced the risk of biochemical recurrence (BCR).

Stolzenburg, et al.[9] (2022) concluded that both LRP and RARP offer high-quality therapy for prostate cancer patients, with robotic assistance providing better functional outcomes, particularly in terms of potency and early continence for eligible patients undergoing nerve-sparing radical prostatectomy.

Lee, et al.[10] (2015) Unadjusted 5-year biochemical recurrence-free survival (BCRFS) rates favored RARP over RRP, but after adjustment for preoperative variables, the BCRFS rates were similar between the two groups. Overall, the surgical approach did not predict biochemical recurrence in multivariate analysis, suggesting that RARP is a feasible treatment option for high-risk PCa with comparable 5-year BCRFS rates to RRP.

Tozawa, et al.[11] (2014) concluded that while RARP offers advantages, such as reduced bleeding, the lack of tactile feedback poses a challenge, necessitating careful consideration by the robotic surgeon to minimize the risk of PSM. In LRP, PSMs were predominantly found in the apex, anterior, posterior, lateral regions of the prostate, and bladder neck, whereas in RARP, PSMs were distributed similarly but with variations in frequencies.

DISCUSSION

Radical prostatectomy (RP) stands as the primary surgical intervention for clinically localized prostate cancer, with robot-assisted RP (RARP) gaining widespread popularity, particularly in the USA and Europe. Currently, over 75% of RARP procedures utilize the da Vinci platform. RARP facilitates early continence recovery and is comparable in safety and

efficacy to laparoscopic radical prostatectomy (LRP) when performed by a laparoscopic surgeon with intermediate experience.[9,12] In this study, we compared the efficacy of RARP and LRP in prostate cancer treatment.

In clinical practice, RARP has shown reductions in operative duration, estimated blood loss, and hospital stay compared to LRP. Additionally, the frequency of positive surgical margins (PSM) decreases with increasing surgeon experience in both RARP and LRP.[13,14] RARP has become widely adopted for localized prostate cancer management due to its advantages, including the high mobility of robotic forceps and the enhanced visualization provided by the 3-D display. Numerous studies have demonstrated that RARP yields safer and more favorable outcomes compared to retropubic radical prostatectomy and LRP.[8,15]

Urinary continence was significantly higher in the RARP group compared to the LRP group, both during the first year post-surgery and throughout the entire follow-up period. Over the 5-year follow-up, the probability of continence was doubled in the RARP group compared to the LRP group. These findings align with recent systematic reviews and meta-analyses, which also reported a higher level of evidence supporting superior continence outcomes at the 1-year mark post-radical prostatectomy.[7]

In a multivariable analysis, potential confounders were considered. The study demonstrated a significant advantage of RARPover other surgical approaches in terms of potency recovery post-surgery, showing a twofold higher probability of potency retention after RARP.[16] These findings are consistent with previous studies, although some variations in results exist, likely due to differences in patient inclusion criteria and surgical techniques. However, the surgical approach did not influence oncologic outcomes, with similar rates of positive surgical margins (PSM) and biochemical recurrence-free survival (BCRFS) observed between RARP and other approaches. Notably, the inclusion of patients who received adjuvant therapy in the analysis might have contributed to slightly higher BCR rates compared to previous studies, but the overall oncologic results remained consistent with existing literature.[10,17]

Recent analyses of laparoscopic radical prostatectomy (LRP) and robot-assisted radical prostatectomy (RARP) have reported varying frequencies of positive surgical margins (PSM). Previous study showed PSM frequencies with RARP ranged from 2 to 59%.[18] This study found relatively high PSM rates with RARP, particularly in cases with tumors located at the posterior and lateral sides. While some reports suggest similar PSM incidences between RARP and retropubic radical prostatectomy, others indicate that the risk of PSM may depend on TNM stage and preoperative PSA levels rather than the surgical technique. Additionally, factors like clinical stage and BMI have been independently associated with PSM incidence after RARP. The location of PSM is crucial, as base PSMs have been linked to a higher risk of biochemical recurrence.[10,11]

The literatures suggested that the distribution of PSMs differs significantly between RARP and LRP, with apical PSMs being more common in LRP due to unclear visualization of the apex.[19] The lack of tactile sensation in RARP poses a potential disadvantage, requiring surgeons to understand and delicately manipulate the robotic system's forceps. Further studies with longer follow-up periods are necessary to assess the implications of these findings on local recurrence.[11,20]

CONCLUSION

Robot-assisted radical prostatectomy (RARP) offers advantages such as quicker recovery and comparable safety to laparoscopic radical prostatectomy (LRP). Studies show better urinary continence and potency outcomes with RARP. While PSM rates vary between RARP and LRP, further research is needed to understand their impact on recurrence. Despite challenges like the lack of tactile sensation in RARP, it remains a popular choice for prostate cancer treatment.

REFERENCES

[1] Rawla P. Epidemiology of Prostate Cancer. World J Oncol. 2019 Apr;10(2):63–89.
[2] Descotes JL. Diagnosis of prostate cancer. Asian Journal of Urology. 2019 Apr 1;6(2):129–36.
[3] Litwin MS, Tan HJ. The Diagnosis and Treatment of Prostate Cancer: A Review. JAMA. 2017 Jun 27;317(24):2532–42.
[4] Allan C, Ilic D. Laparoscopic versus Robotic-Assisted Radical Prostatectomy for the Treatment of Localised Prostate Cancer: A Systematic Review. Urologia Internationalis. 2015 Jul 18;96(4):373–8.
[5] Basiri A, de la Rosette JJ, Tabatabaei S, Woo HH, Laguna MP, Shemshaki H. Comparison of retropubic, laparoscopic and robotic radical prostatectomy: who is the winner? World J Urol. 2018 Apr 1;36(4):609–21.
[6] Carbonara U, Srinath M, Crocerossa F, Ferro M, Cantiello F, Lucarelli G, et al. Robot-assisted radical prostatectomy versus standard laparoscopic radical prostatectomy: an evidence-based analysis of comparative outcomes. World J Urol. 2021 Oct 1;39(10):3721–32.
[7] Porpiglia F, Fiori C, Bertolo R, Manfredi M, Mele F, Checcucci E, et al. Five-year Outcomes for a Prospective Randomised Controlled Trial Comparing Laparoscopic and Robot-assisted Radical Prostatectomy. European Urology Focus. 2018 Jan 1;4(1):80–6.

[8] Okegawa T, Omura S, Samejima M, Ninomiya N, Taguchi S, Nakamura Y, et al. Laparoscopic radical prostatectomy versus robot-assisted radical prostatectomy: comparison of oncological outcomes at a single center. Prostate International. 2020 Mar 1;8(1):16–21.
[9] Stolzenburg JU, Holze S, Arthanareeswaran VKA, Neuhaus P, Do HM, Haney CM, et al. Robotic-assisted Versus Laparoscopic Radical Prostatectomy: 12-month Outcomes of the Multicentre Randomised Controlled LAP-01 Trial. European Urology Focus. 2022 Nov 1;8(6):1583–90.
[10] Lee D, Choi SK, Park J, Shim M, Kim A, Lee S, et al. Comparative analysis of oncologic outcomes for open vs. robot-assisted radical prostatectomy in high-risk prostate cancer. Korean J Urol. 2015 Aug;56(8):572–9.
[11] Tozawa K, Yasui T, Umemoto Y, Mizuno K, Okada A, Kawai N, et al. Pitfalls of robot-assisted radical prostatectomy: A comparison of positive surgical margins between robotic and laparoscopic surgery. International Journal of Urology. 2014;21(10):976–9.
[12] Alemozaffar M, Sanda M, Yecies D, Mucci LA, Stampfer MJ, Kenfield SA. Benchmarks for Operative Outcomes of Robotic and Open Radical Prostatectomy: Results from the Health Professionals Follow-up Study. European Urology. 2015 Mar 1;67(3):432–8.
[13] Ploussard G, de la Taille A, Moulin M, Vordos D, Hoznek A, Abbou CC, et al. Comparisons of the Perioperative, Functional, and Oncologic Outcomes After Robot-Assisted Versus Pure Extraperitoneal Laparoscopic Radical Prostatectomy. European Urology. 2014 Mar 1;65(3):610–9.
[14] Yossepowitch O, Briganti A, Eastham JA, Epstein J, Graefen M, Montironi R, et al. Positive Surgical Margins After Radical Prostatectomy: A Systematic Review and Contemporary Update. European Urology. 2014 Feb 1;65(2):303–13.
[15] Huang HW, Yan LM, Yang YL, He X, Sun XM, Wang YM, et al. Bi-frontal pneumocephalus is an independent risk factor for early postoperative agitation in adult patients admitted to intensive care unit after elective craniotomy for brain tumor: A prospective cohort study. PLOS ONE. 2018 Jul 19;13(7):e0201064.
[16] Sood A, Jeong W, Peabody JO, Hemal AK, Menon M. Robot-Assisted Radical Prostatectomy: Inching Toward Gold Standard. Urologic Clinics of North America. 2014 Nov 1;41(4):473–84.
[17] Chennamsetty A, Hafron J, Edwards L, Pew S, Poushanchi B, Hollander J, et al. Predictors of Incisional Hernia after Robotic Assisted Radical Prostatectomy. Adv Urol. 2015;2015:457305.
[18] Papachristos A, Basto M, te Marvelde L, Moon D. Laparoscopic versus robotic-assisted radical prostatectomy: an Australian single-surgeon series. ANZ Journal of Surgery. 2015;85(3):154–8.
[19] Mistretta FA, Grasso AA, Buffi N, Cozzi G, De Lorenzis E, Fiori C, et al. Robot-assisted radical prostatectomy: recent advances. Minerva Urol Nefrol. 2015 Sep;67(3):281–92.
[20] Song J, Eswara J, Brandes SB. Postprostatectomy Anastomosis Stenosis: A Systematic Review. Urology. 2015 Aug;86(2):211–8.