The evolution of 3D laparoscopic radical prostatectomy in a high volume center

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ABSTRACT

Introduction and Objectives.
Radical prostatectomy is a key treatment option for non-metastatic prostate cancer, with various surgical approaches available, including open surgery, conventional laparoscopy, 3D laparoscopy, and robotic-assisted techniques. While open surgery was traditionally considered the gold standard, laparoscopic radical prostatectomy (LRP) has demonstrated advantages such as reduced blood loss, shorter hospital stays, and comparable oncological and functional outcomes. Robotic radical prostatectomy (RRP) has become the dominant approach in many regions due to enhanced visualization and ergonomics, though its high cost and limited availability restrict its use in resource-limited settings. The optimal surgical approach remains debated, necessitating further comparative studies.

Materials and Methods.
This retrospective study analyzed 678 radical prostatectomies performed between 2017 and December 2024 by a single uro-oncology surgeon using a 3D laparoscopic approach. The study focused on the first and last 50 cases of 3D laparoscopic radical prostatectomy (LRP) performed for non-metastatic localized prostate cancer.Preoperative variables such as age, serum PSA levels, and biopsy Gleason scores were recorded. Surgical steps included preperitoneal access, bladder neck preservation when feasible, nerve-sparing when recommended, dorsal vein complex ligation, and urethral anastomosis using a unidirectional monofilament suture. Perioperative outcomes assessed included operating time, blood loss, neurovascular bundle preservation, transfusion rate, complication rate (Clavien-Dindo scale), continence, erection, positive surgical margins, hospital stay, and catheter removal. Follow-up data on erectile dysfunction and continence were obtained from medical records and telephone interviews. Patients lost to follow-up were excluded.

Results.
With increased surgical experience, perioperative outcomes improved significantly in the second group. Operative time and blood loss were reduced, and neurovascular bundle preservation was achieved in more cases. Postoperative recovery was faster, with earlier ambulation, shorter ICU stay, and quicker hospital discharge.Complication rates decreased, with fewer mild postoperative issues and only one significant complication in the first group. Continence rates remained comparable, but catheter removal was earlier in the second group, correlating with improved functional outcomes. No rectal injuries were recorded.

Conclusions.
In high volume institutions procedures such as 3D laparoscopic radical prostatectomy can be standardised as a procedure with oncological and functional improvement. A strong bond between the surgery team and ICU team is important in order to achieve maximal benefit.

Key-words:prostate cancer; 3D laparoscopy;

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INTRODUCTION AND OBJECTIVES

Radical prostatectomy is a recognized treatment option for non-metastatic prostate cancer in low, intermediate, and select high-risk cases. Several surgical techniques are available, including open surgery and minimally invasive methods such as conventional laparoscopy, 3D laparoscopy, and robotic-assisted procedures. Traditionally, open radical prostatectomy(ORP) was considered the gold standard. However, since the introduction of laparoscopic radical prostatectomy (LRP) in the early 1990s, studies have demonstrated its benefits, including reduced blood loss, lower transfusion rates, less postoperative pain, shorter hospital stays, and faster catheter removal, while maintaining comparable oncological and functional outcomes[1,2].

Robotic radical prostatectomy (RRP) was introduced in 2003 to address the technical limitations of conventional laparoscopic radical prostatectomy (LRP). It has become the preferred approach due to its enhanced three-dimensional visualization of pelvic anatomy, improved ergonomics, and greater precision. While RRP is widely adopted in Western countries, its high cost and limited availability have hindered its use in developing regions[3]. Additionally, no clear oncological or functional advantages over other techniques have been demonstrated. Meanwhile, 3D laparoscopy offers improved anatomical visualization similar to robotics, helping to mitigate some of the limitations of 2D laparoscopy and open surgery[4].

The optimal approach for radical prostatectomy, considering postoperative complications, functional recovery, and oncological outcomes, remains a topic of debate despite advancements in minimally invasive techniques such as laparoscopy and robotic surgery[5].

3D LRP can offer the advantages of reduced blood loss, postoperative pain, and shortened hospital stays along with functional and oncological outcomes that were comparable to those of RRP[6]. Both LRP and ORP have shown comparable oncologic and functional outcomes to RRP after an intermediate-term follow-up, with benefits in terms of blood loss, recuperation, and appearance[7]. Long-term research is necessary to conclusively identify the benefits of each method, though.

Through our retrospective study we aim to identify the improvements in intraoperative and postoperative functional an oncological outcomes, that can be achieved in a large experienced center.

MATERIALS AND METHODS

Study design and population
All of the patients with prostate cancer who had radical prostatectomy at our institute between 2017 and December 2024 were retrospectively analyzed, a total of 678 radical prostatectomies were performed by a single-trained uro-onco surgeon performing both 3D laparoscopic procedures. The first 50 prostatectomies and last 50 cases were investigated.

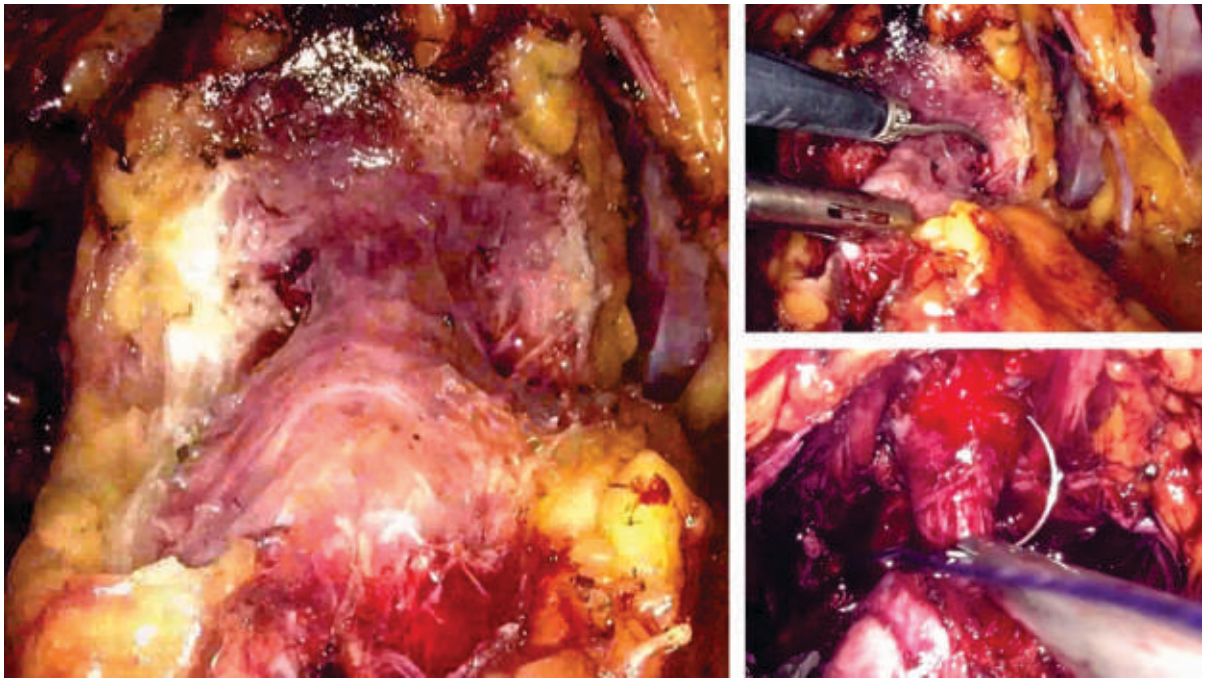
Outcome measurements and statistical analysis
The study comprised patients with non-metastatic localized prostate cancer who were judged surgically suitable for surgery. For both groups, preoperative variables such as age, serum PSA, preoperative 12 core TRUS biopsy with Gleason score, and other pathologies were recorded.

3D LRP (laparoscopic prostatectomy) was carried out. When feasible and recommended, nerve sparing was carried out. To ensure that the maximum urethral length was available for anastomosis while maintaining oncological safety, the urethra was separated at the apex.

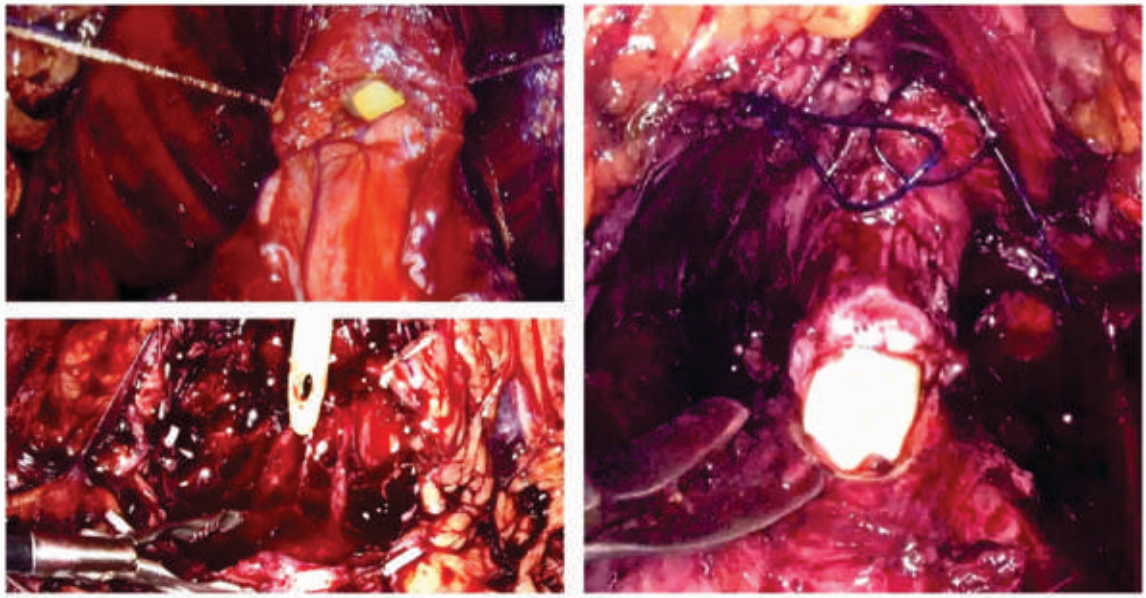
In every instance we opted for a preperitoneal access, identification of the bladder neck and preserve it, when possible[8,9], (patients without TURP prior to surgery), cold dissection of bladder neck, identification of seminal vesicles, deferent ductus incision, posterior plane dissection, ligation of dorsal vein complex, urethral dissection and incision, running suture anastomosis (monofilament, unidirectional thread) (Pictures 1 and 2). Perioperative results were obtained in the form of total operating time, estimated blood loss, neurovascular bundle preservation, transfusion

rate, ICU stay, time to ambulation, Clavien Dindo scale complication rate, continence, erection, positive margins, hospital stay and catheter removal. Additionally, final histopathological characteristics were recorded. Documented were follow-up information evaluating functional outcomes such as erectile dysfunction and continence.

Every piece of information was gathered from medical records that were kept up to date. Missing information was gathered via telephone interviews. Study participants who were lost to follow-up were not included.



Picture 1. Left: bladder neck preservation. Top right: Bladder neck cold scissor incision. Bottom Right: suture of dorsal vein complex



Picture 2. Top left: 2 needle running suture, monofilament unidirectional thread. Bottom Left: neurovascular bundle preservation. Right: urethral preservation and cold scissor incision

RESULTS

Demographic characteristics
Between Septembrie 2017 and December 2024, a total of 678 patients underwent 3D laparoscopic radical prostatectomy; the first 50 were selected as Group1 and the last 50 represented Group2. Open radical prostatectomies were not included in the study.

According to demographic data (Table 1), for the first group the average age was 68 (51-81), and for the second group 67(53-77). In the first group, the mean serum PSA before surgery was 10.9 ng/ml (1.1–25 ng/dl), for the second group 10.3 ng/ml (1.7-21).

According to demographic data (Table 1), the patients' mean age ranged from 51 to 81 years.

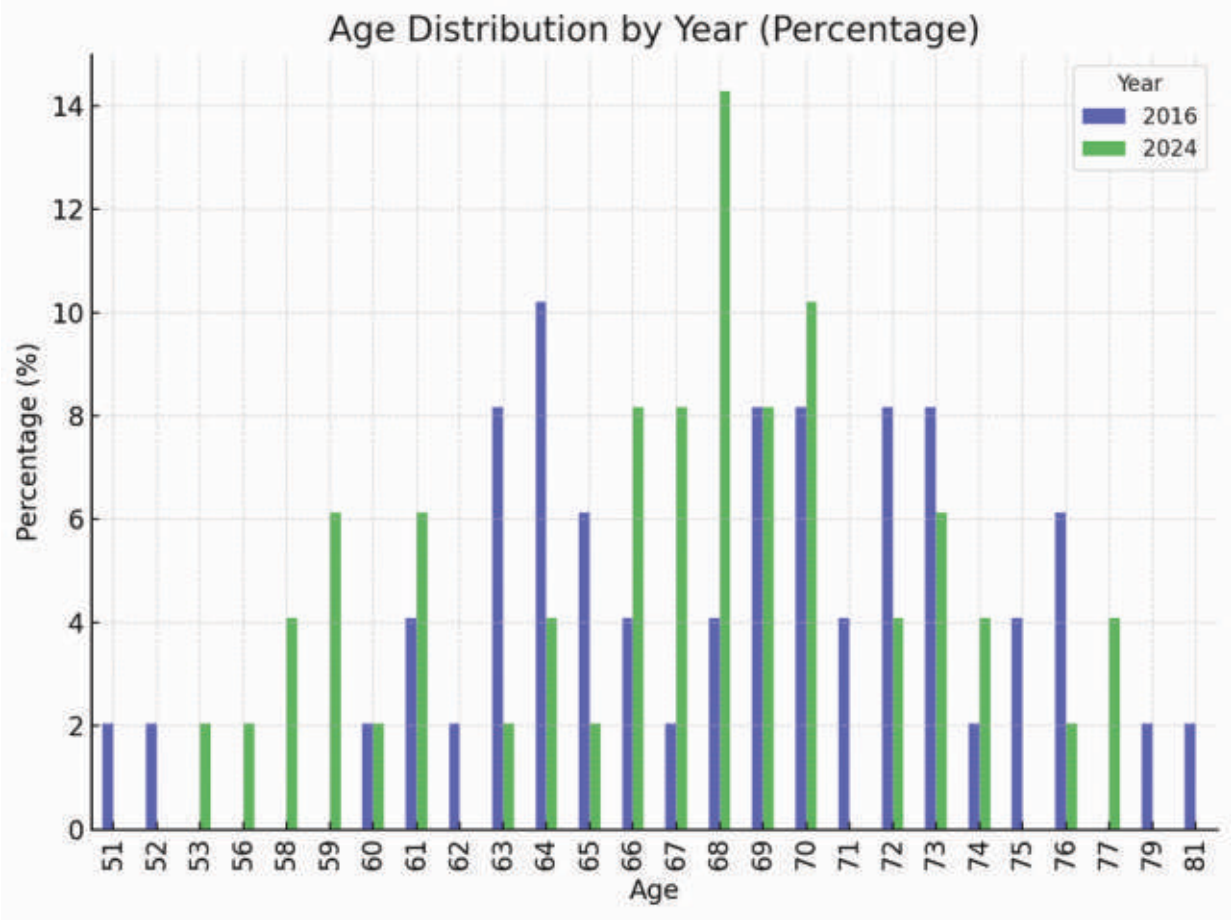


Table 1. Age distribution of patients. The blue lines represent the group of the first 50 patients and the green lines represent the group of the last 50 patients.

Many of the patients presented with associated pathologies, some of which were severe as stroke, atrial fibrillation, cardiac insufficiency, chronic obstructive pulmonary disease or heart attack. (Table 2)

Pathology	2016	2024
Cardiovascular	24	32
Urologic	3	4
Respirator	2	7
Neurologic	1	4
Other	28	15

Table 2. The associated pathologies that the patients presented at hospital admission.

Perioperative outcomes and Complications

In the second Group of 3D laparoscopic surgery, perioperative parameters (Table 3) changed significantly as the surgeon's experience grew. The average intraoperative time was 150 minutes vs 75 when lymph nodes dissection was needed and 116 vs 52 minutes without lymph node dissection.

The average blood loss was about 350ml for Group 1 and under 100ml for Group 2. Thus, the results of laparoscopic surgery improved as our team's experience grew. For Group 1 there was no neurovascular preservation, compared with Group2 where in 30% of cases the surgeon managed to unilateral preserve the bundle and in 15% of cases, bilateral preservation. A total of 8% of patients from Group 1 received blood transfusion, stayed a mean time of 2 days in the ICU unit, were mobilised at 8-16 hours post operative and were discharged in day 5, but for the second group, none received blood transfusion, they were sent on the ward on the day of the surgery, mobilised after 4-6 hours and discharged usually in day 2, after drain removal (Table 4).

Using the Clavien Dindo scale to measure postoperative complications, Group 2 presented only grade 1-2 in 15% of cases which translates in some mild hematuria of ecchymosis forming in the post op period which were treated with farmacologic hemostatic agents. For the same 1-2 grade, the first group presented a 27% rate of complications. Only 1 patient from Group 1 presented grade 3 complications due to a failed Folley catheter which deflated and came out 18 hours after surgery. For the 2 groups, no rectal injuries were recorder during or after surgery.

The continence rate was good for both groups without any significant difference, with a 3 month continence of 75%. In the first group, no neurovascular bundle were preserved but for the second group, the preservation was performed in 45% of cases and of these, 75% were continent in the first 3 months. In group 1, the catheter was removed at 21 days but for the second group, the period shortened to 10 days.

		2016 (50)	2024 (50)
mean operative time (min)	with lymph nodes	150	75
	without lymph nodes	116	52
estimated blood loss (ml)		350	<100
neurovascular preservation (%)	unilateral	0	30
	bilateral	0	15
transfusion		8%	0%
ICU stay		2	0
ambulation (hours)		8-16	4-6
mean postop hospital stay (days)		5	2,5
Clavien-Dindo complication scale(%)	1	12	10
	2	15	5
	3	1	0
	4	0	0
	5	0	0
continence	3 months	75	75
	6 months	90	90
	12 months	95	95
erection (% of neurovascular bundle sparing)	3 months	0	60
	6 months	0	70
	12 months	0	75
positive margins(%)		37	25
catheter removal (days)		21	10

Table 3. Perioperatory events

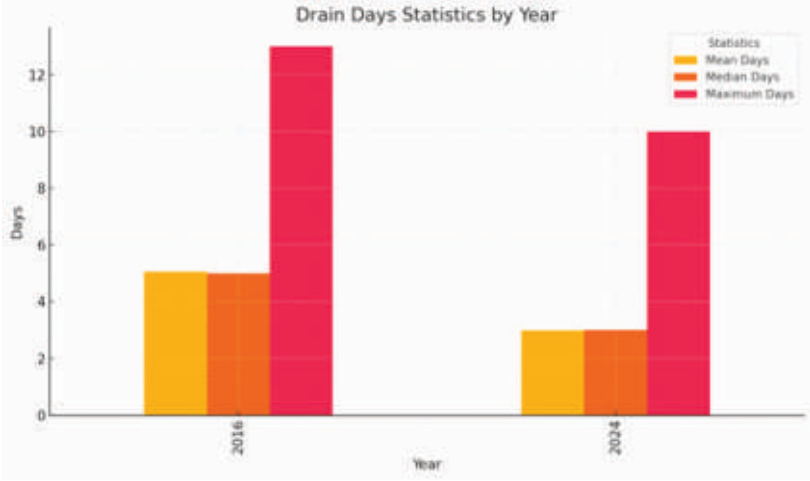


Table 4. Days to drain removal

Pathological Outcomes

The first 50 cases which were operated in 2017, presented a pT3 stage with a higher frequency that the second group (Table 5), because the positive margin rate was higher, 37,5% vs 25%.(Table 6)

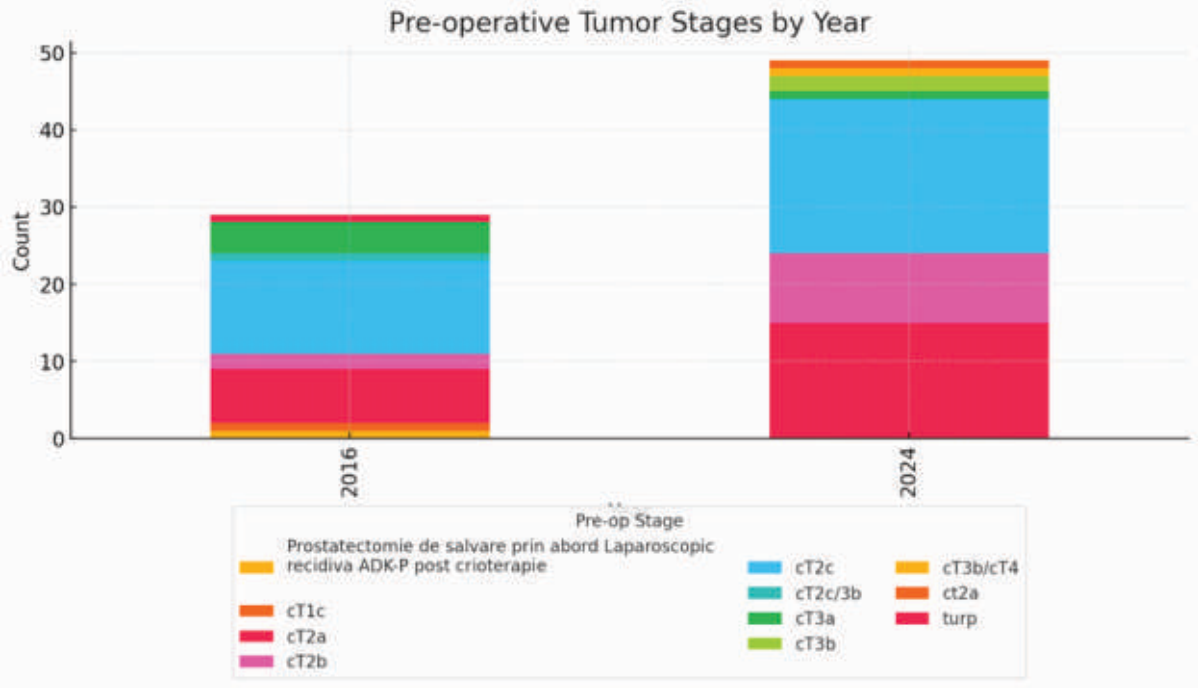


Table 5. Distribution of cases based on post op pathology report

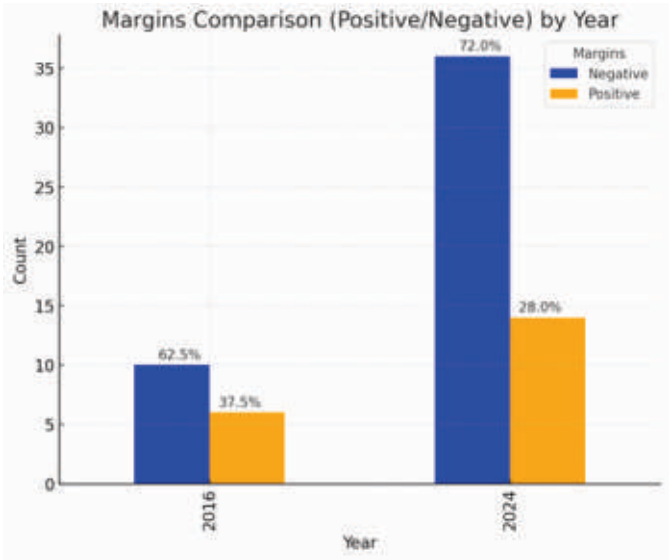


Table 6. Rate of negative and positive margins, as resulted in the post op pathology report

DISCUSSIONS

In 2017, the team was young, and especially the main surgeon, who was starting his laparoscopic career. He was trained as a fellow in uro-oncology and laparoscopy but now, the goal was to standardise the procedure and improve surgical outcomes. In this period, 3D technology was improving, 3D laparoscopy was available and the robotic surgeons started describing the pelvic, prostatic and radical prostatectomy technique in detail[10,11]. As much as possible, we tried to also implement a fast track surgery type of post op period[12].

The technique was standardized, but the team needed to gain more experience in order to shorten surgery time and show some benefit in the post op period. This is the reason why at first, the patients were mobilised a bit later, usually in the evening or the next morning, 8-16 hours after surgery. The longer anestesia time can be a cause for which the patients were a bit more sleepy in the afternoon[13].They were mobilised at bedside, and only if capable, they walked. As time passed and surgery time shortened, the patients were more alert and willing to walk in the first 4-6 hours after surgery, as well, the anestesist gain confidence and started sending the patients on the ward in the day of the surgery. Slowly fast-track surgery was implemented in our center[14].

Through all the 678 3D laparoscopic prostatectomies, the surgeon experienced 9 rectal injuries which were all sutured intraoperative and only once a stoma was needed. For the first 50 cases, the favorable cases were selected, but later on, the more difficult cases emerged, so obviously the risk of injury is higher. The Institute is a high volume center for uro-oncological surgeries. During this time between 2017 and 2024, fellows have changed, the surgeon performs the same standardized surgery and teaches it the same way. After the first 300 cases, we had to perform a salvage prostatectomy for a patient with colostomy, a detail which only permitted placement of 3 trocars. This was the first 3 trocar 3D laparoscopic radical prostatectomy, but soon others followed.

The financial status is an important aspect that should not be neglected. Laparoscopy became accessible and widespread in our country, comparing with the robot which is generally used in the private clinics[15]. Open surgery remains a cheaper option, but has the downside of a longer postop recovery, higher blood loss, transfusion and complication rates, slower continence recovery, and later social reintegration, even though the difference is not always statistically significant[16,17].

This is a retrospective study which has its limitations but even though the robot is here and steals the spotlight, we consider that 3D laparoscopy still plays an important role in the prostate cancer stage, now and in the future, so we consider that our effort in improving oncological and functional parameters has paid off.

CONCLUSIONS

Increased surgical experience with 3D laparoscopic radical prostatectomy led to significant improvements in operative efficiency, reduced blood loss, and faster postoperative recovery. The refinement of surgical techniques allowed for more frequent neurovascular bundle preservation, contributing to better functional outcomes. Additionally, complication rates decreased without compromising oncological safety. These findings highlight the importance of experience and technique optimization in improving patient outcomes in minimally invasive prostate cancer surgery.

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