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REVIEW

Robot-assisted simple prostatectomy versus laparoscopic simple prostatectomy: a narrative review of the literature and the state of art

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Abstract

Introduction: Robot-Assisted Simple Prostatectomy (RASP) and Laparoscopic Simple Prostatectomy (LSP) are minimally invasive surgeries to treat symptoms from benign prostate hyperplasia (BPH) and results have demonstrated benefits over Open Simple Prostatectomy (OSP), but evidence has not established yet which technique is superior. We conducted a narrative review of literature with the aim of determining superiority. Methods: We searched PubMed, Embase, Web of Science and Google Scholar through April-May, 2026. The search was performed using the following terms: (Robot OR Robot-assisted OR Robotic) AND (Laparoscopy OR Laparoscopic) AND (Simple Prostatectomy OR Adenomectomy). Inclusion criteria were: (1) patients with prostate volume 80–100 mL; (2) undergoing LSP, LA, or RASP; (3) reporting data on perioperative, functional, or complication outcomes; and (4) study types including case reports (≥10 patients), prospective studies, retrospective studies, comparative studies, or randomized controlled trials. Results: From reviewed literature, a total of 91 articles were selected, of which 24 relate LSP/LA, 30 to the RASP, 11 to single-port RASP, 20 to comparative studies, and 4 are review articles. Conclusions: The RASP and LSP techniques are essentially equivalent in terms of perioperative and functional outcomes; however, RASP may simplify learning curve, enabling significant refinements in surgical techniques and leading into improvements regarding perioperative morbidity. Comparative studies of these techniques would be necessary to assess cost-effectiveness of both techniques

Keywords: RASP, LSP, LA, Benign prostatic hyperplasia

Introduction

European Urological Association (EUA) and American Urological Association (AUA) guidelines recognize Open Simple Prostatectomy (OSP) as an effective and durable procedure for treating Lower Urinary Tract Symptoms (LUTS) caused by benign prostatic hyperplasia (BPH) in enlarged glands (80–100 mL). Since almost all prostate adenoma tissue is removed, OSP provides excellent outcomes; however, it remains the most invasive surgical method [1]. Mariano *et al.* presented the first description of Laparoscopic Simple Prostatectomy (LSP) combining the advantages of functional outcomes of open surgery with benefits of minimally invasive procedures, such as reduced pain, shorter hospital stays, less bleeding and a quicker recovery [2, 3]. Sotelo *et al.* present the first series of Robot-Assisted Simple Prostatectomy (RASP) by replicating laparoscopic technique using a robotic approach, thereby offering the same advantages as laparoscopy, combined with the well-known benefits of the robotic approach in terms of improved ergonomy, shorter learning curves, high precision achieved through three-dimensional vision, and meticulous enucleation made possible by the flexibility of the robotic forceps movements [4].

In scientific terminology, the terms Laparoscopic Adenomectomy (LA) and LSP are used interchangeably and are regarded as the same surgical procedure. In contrast, with regard to the robotic approach, most publications focus on a single term: RASP.

The fact is that LSP and RASP are classified as minimally invasive surgeries (MIS) for BPH treatment, and their

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results have clearly demonstrated their benefits over OSP. However, there is no consensus as to which of the two is superior, and furthermore, their application does not depend on clinical criteria, but rather on the technological resources available at each hospital or the specific practices of each urology department. We conducted a narrative review of current scientific literature on both procedures and the available comparative studies between them, with the aim of determining which is superior.

Methods

We searched PubMed, Embase, Web of Science and Google Scholar through April–May 2026. To optimize the quality of our manuscript and the literature search, we applied the Assessment of Narrative Review Articles (SANRA) scale [5], Futhermore, we used guidelines recommendations to aid producers of narrative reviews [6].
The search was performed using the following terms (Robot OR Robot-assisted OR Robotic) AND (Laparoscopy OR Laparoscopic) AND (Simple Prostatectomy OR Adenomectomy). Each manuscript was reviewed manually to extract relevant information and ensure nothing was overlooked. Our search included articles in English and Spanish from 2002 to 2026. The manuscripts that were excluded were editorial comments, meeting abstracts and unpublished studies. Inclusion criteria were defined as shown: All patients were diagnosed with large BPH (prostate volume 80-100 mL); undergoing LSP/LA/RASP ; including data about perioperative, functional and complications outcomes; study type (case reports at least 10 patients [exception: original and innovative articles presenting new techniques, new approaches or new technologies], prospective, retrospective, comparative or Randomized Controlled Trial).

Results

From the literature reviewed, a total of 91 articles were selected, of which 24 relate LSP/LA [3, 7-30], 30 to RASP [4, 31-60], 11 to single-port RASP [61-71], 20 to comparative studies [71-91], 4 are review articles [92-95].

Established evidence and technical maturity of LSP

Since the first description of LSP in 2002 [3], numerous clinical case reports, case series, larger cohort studies, systematic reviews, comparative studies between open and laparoscopic techniques have been published. These studies demonstrated the feasibility and safety of the laparoscopic technique in the treatment of large prostate adenomas. In addition, comparative studies between LSP and open surgery report the advantages of the laparoscopic technique in terms of magnified vision which allows for selective hemostasis and meticulous enucleation, reduced perioperative bleeding, lower transfusion rates, and reduced requirements for post-operative bladder irrigation, shorter catheterization times and shorter hospital stays, as opposed to longer operating times, the need for expertise in laparoscopy and a long learning curve. Furthermore, it was demonstrated that both techniques offer good functional outcomes in long-term improving urinary symptoms and patients' quality of life [3, 7-30].

Technical innovations and procedural evolution in RASP

In 2008, Sotelo *et al*. published the first series of RASP cases, demonstrating the feasibility and safety of this procedure in the treatment of large adenomas. In this initial series, the authors performed a transperitoneal approach and subsequently accessed the retropubic space to carry out surgical steps similar to those in the Millin technique [4].
Similarly to what occurred with the first description of the LSP, numerous clinical case reports, case series, and larger cohort studies have been published. All authors agree that the RASP technique provides a better view of the dissection plane, ensuring a more meticulous dissection of the adenoma and more precise selective hemostasis. Consequently, the benefits of robotic surgery have enabled the technique of simple prostatectomy to evolve into different methods of approaching adenoma and optimize the reconstructive aspects of the surgery to minimize compli-

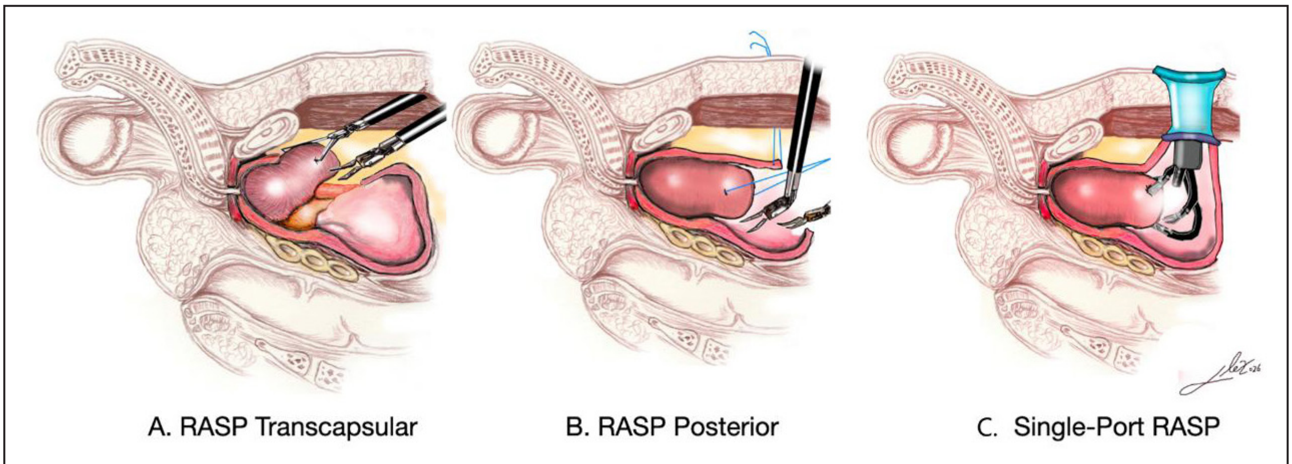

Figure 1. **RASP Techniques.** (**A**) RASP Transcapsular; (**B**) RASP Posterior; (**C**) Single-Port RASP.

cations, reduce the need for bladder irrigation and shorten the duration of catheterization [31-60]. Similarly, the adaptation of robotic devices for Single-Port (SP) surgery has also enabled the development of various variations of the surgical technique for simple prostatectomy using this particular approach [61-71].

The first published cases of RASP were performed using a transperitoneal approach, however [4, 31], John *et al.* reported the first series using an extraperitoneal (preperitoneal) approach thereby avoiding access to the peritoneal cavity [32] (Figure 1A).

In 2015, Pokorny *et al.* presented the largest RASP series reported to this date (N = 67) with excellent functional outcomes and very effective treatment for large BPH [39]. Another large retrospective series of 150 patients, presented by Lee *et al.*, evaluated the long-term follow-up outcomes of 31.3 months after RASP. Authors reported a low incidence of late complications and noted that outcomes in terms of urinary function improve in the early postoperative care, reaching their maximum improvement at 3 months, and maintaining excellent urinary function outcomes to at least 36 months [47].

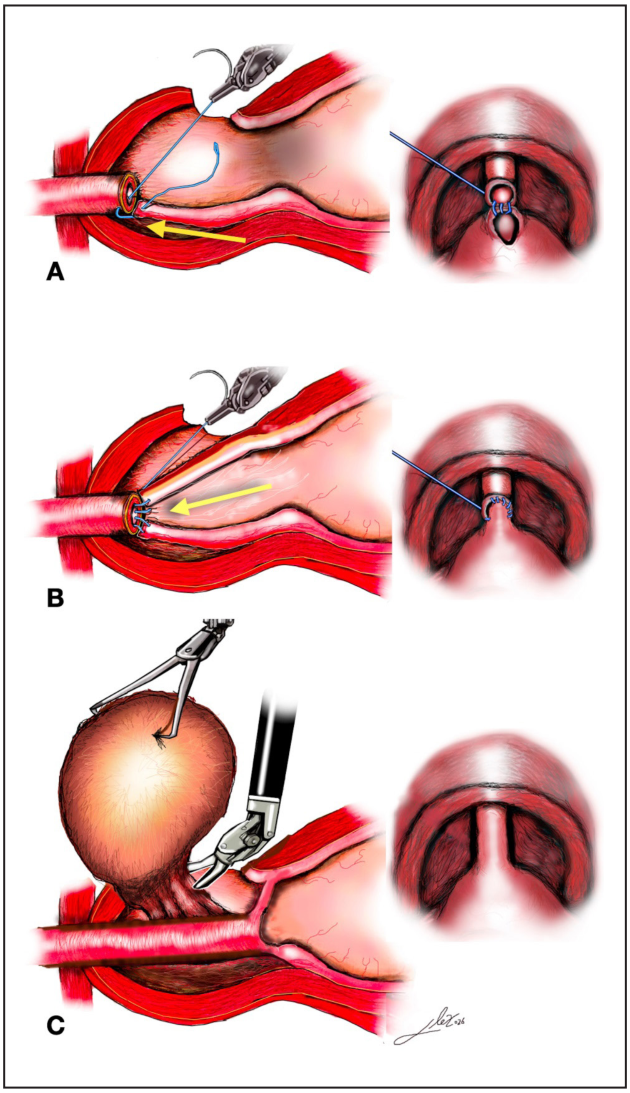

Figure 2. **Reconstruction (Trigonization and Urethro-Vesical).** (**A**) Trigonization to prostatic fossa and posterior edge of urethral stump; (**B**) Urethro-vesical anastomoses; (**C**) Urethral-Sparing technique.

Trigonization and vesico-urethral anastomosis

During the trigonization of the prostatic fossa or the reconstruction of the bladder neck, RASP has made the greatest contribution to minimizing the need for bladder irrigation and reducing the duration of bladder catheterization (Figure 2A).

Based on this concept, Coelho *et al.* presented a modified technique of vesico-urethral anastomosis during the RASP. This technique involves creating a suture line that connects the bladder neck to the urethral stump, isolating the bleeding surface from the prostatic bed, thereby eliminating the need for bladder irrigation and reducing postoperative bleeding and the length of hospital stay [34]. The published studies report no need for bladder irrigation and hospital stays of just one day [34, 35, 40, 43, 49, 58] (Figure 2B).

Clavijo *et al.* proposed an 'intrafascial' approach which, in addition to eliminating bladder irrigation, reduces postoperative bleeding and the risk of developing prostate cancer [37, 52].

Shumaker *et al.* presented one of the largest retrospective series, involving 292 patients with long-term follow-up of 22 months. The authors demonstrated that RASP with circumferential vesicourethral anastomosis produces significant improvements in urinary symptoms and has minimal impact on erectile function, although a small percentage of men do experience sustained bothersome or distressing changes in orgasm following RASP [58].

Posterior approach (Retzius-Sparing)

A new transperitoneal posterior approach was proposed by Leslie *et al.*, similar to the Retzius-sparing technique in robot-assisted radical prostatectomy [38]. In this technique, a transverse cystotomy is performed on the bladder dome, and two percutaneous sutures are placed to keep the edges of the bladder incision and allow exposure to the prostate. This technique is known as the "Posterior" approach or preservation of the Retzius space. The authors argue that this approach allows for better visualization and preservation of the bladder neck [38, 44] (Figure 1B).

In 2024, Novara *et al.* presented only prospective series on the Retzius preserving RASP technique, in a single-centre study of 87 patients. Authors reported good perioperative outcomes and low prevalence of high-grade complications. Furthermore, significant urinary symptoms relief was achieved, although some patients experienced slight urgency or stress urinary incontinence [56].

Urethra-sparing

The trend towards minimizing invasiveness, combined with the aim of avoiding bladder irrigation and preserving ejaculatory function, led to the development of the urethral preservation technique. Quan *et al.* replicated Madigan's urethral preservation technique using a laparoscopic approach [22]. This same principle has been applied by several authors during the RASP. Wang *et al.* reported the first series of RASP procedures with urethral-sparing in

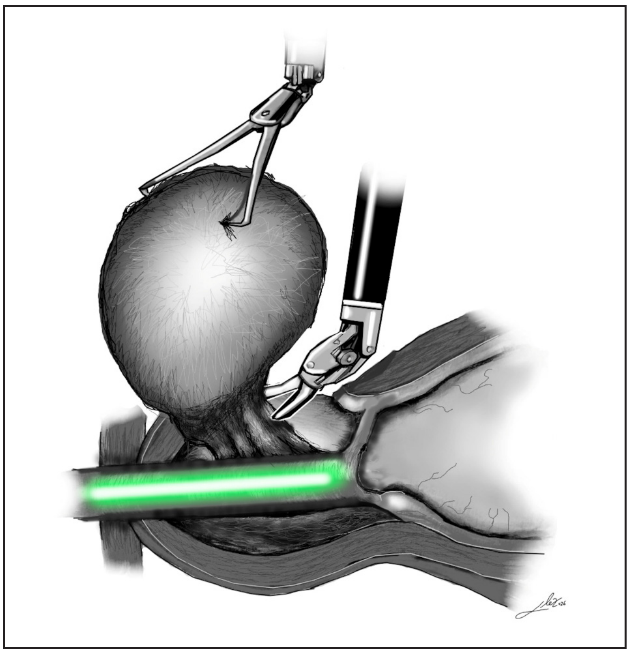

Figure 3. Urethral Sparing technique with near-infrared fluorescence imaging-guided.

a total of 27 patients. In seven cases, urethral repair was required, and 13 of the patients kept normal ejaculatory function [45]. Porpiglia *et al*. preserved ejaculation in 81% using the urethra-sparing technique in a series of 92 cases, of which 56 achieved complete preservation of the urethra [51] (Figure 2C).

Simone *et al*. proposed a retrograde intra-urethral injection of indocyanine green to optimize visualization of the urethra during urethral-sparing surgery. In this series of 12 cases, the authors avoided bladder irrigation in 83.4% of patients and achieved satisfactory ejaculation in 66% of cases [46] (Figure 3).

Choi *et al*. compared the outcomes of urethra-sparing RASP versus the non-urethra-sparing technique in a series of 62 patients and observed significant advantages with the urethra-sparing technique in terms of operative time (123.4 minutes *vs*. 133.7 minutes), length of hospital stay (2.9 days *vs*. 4.6 days), duration of bladder catheterization (2.4 days *vs*. 8.1 days), and by maintaining anterograde ejaculation in 78.6% of cases in the preservation group [53].

Techniques with vascular control

Some authors reported RASP techniques involving vascular management to minimize intraoperative bleeding. One of this was done with a temporary bilateral occlusion of the internal iliac arteries [41], or too through embolization of the prostatic arteries [50].

RASP with new robotic platform

New robotic platforms have recently been incorporated into the robotic surgery armamentarium. One of these is the Hugo-RAS system (Medtronic), which is perhaps one of the most popular systems currently available. Mottaran *et al*. reported the first case of RASP using this technology in 2023 [54] and Piro *et al*. published the first series of RASP cases using the Hugo-RAS system, involving a total of 20 patients [55]. Balestrazzi *et al*. recent study compared 20 cases of RASP performed using the da Vinci system with 20 cases operated on using the Hugo-RAS platform. In this comparative study, the authors concluded that the results were equivalent in terms of operative time, intraoperative blood loss, length of hospital stay, catheterization time and perioperative complications [82] (Figure 4). Qureshi *et al*. presented the first prospective series of a total of 82 patients who underwent RASP surgery using Versius technology (CMR Surgical) [59]. The results and details of manuscripts about RASP are shown in Table 1.

Preliminary clinical application of single-port robotic platforms in simple prostatectomy

Advances in minimally invasive techniques led to the performance of LSP via Laparoscopic Single-Site surgery [61-63]. Desai *et al*. introduced a technique involving a percutaneous approach to the bladder to perform enucleation of the prostate adenoma using a pneumovesicum by the concept of SP [61, 63]. Recent advances in robotics technology enabled Intuitive's da Vinci system to develop the SP platform, and in 2018 it was approved by the Food and Drug Administration (FDA) for prostatic surgeries.

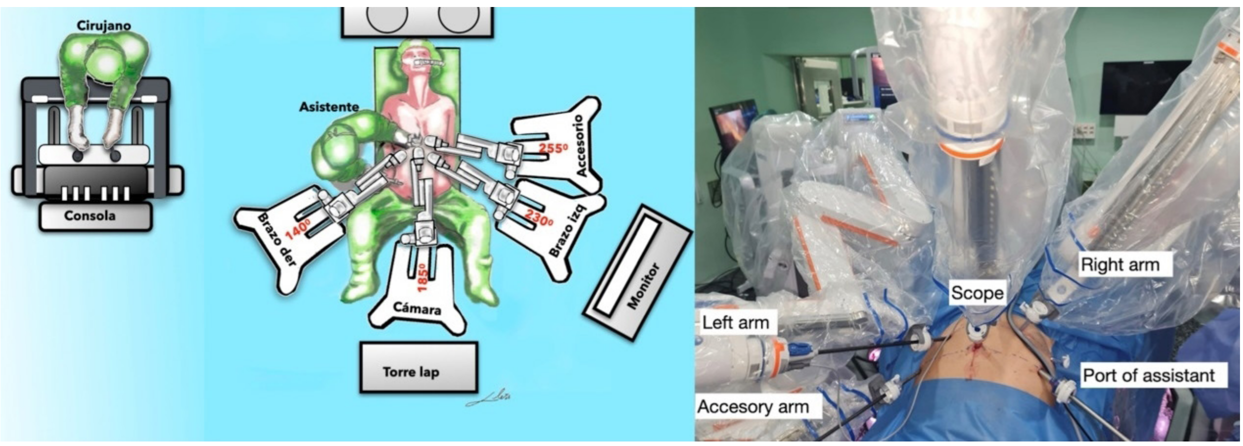

Figure 4. RASP with Hugo-RAS technology. (**A**) Room-set; (**B**) Robotic arms and ports placements.

Table 1. Baseline characteristics and perioperative outcomes of included robotic-assisted simple prostatectomy (RASP) studies.

Study	Design / LoE	N	Prostate volume (mL)	Approach/ technique	Robot type	Operative time (min)	EBL (mL)	LOS (days)	Catheter duration (days)	Key finding
Yuh *et al.*	CS / Level 4	3	301 (66–640)	EP / RP (Millin)	dV-MP	211 (178–230)	558 (150–1125)	1.3 (1–3)	-	Replicates the classic open Millin retropubic approach via a pure extraperitoneal robotic route.
John *et al.*	CS / Level 4	13	100 (90–180)	EP / TV	dV-MP	210 (150–330)	500 (100–1100)	-	6 (3–15)	Preperitoneal robotic access for transvesical adenomectomy that completely avoids the peritoneal cavity.
Uffort *et al.*	CS / Level 4	15	46.4 (4–114)	TP / TV	dV-MP	128.8 (70–172)	139.3 (25–350)	2.5 (1–4)	4.6 (2–10)	Highlights transperitoneal RASP as a safe and effective minimally invasive alternative to open surgery.
Coelho *et al.*	RC / Level 4	6	157 (90–300)	TP / TV	dV-MP	90 (75–120)	208 (100–300)	1	-	Direct vesicourethral anastomosis after enucleation significantly reduces urinary bleeding and catheter time.
Dubey *et al.*	CS / Level 4	3	-	TP / TV	dV-MP	220	160	3.5		Urethrovesical reconstruction with posterior trigonization, optimizing early continence recovery.
Vora *et al.*	RC / Level 3b	13	127 (100–165)	TP / TV	dV-MP	179 (90–270)	219 (50–500)	2-7 (1–8)	8.8 (5–14)	Multi-institutional study confirming RASP is highly effective and reproducible for glands > 100 g.
Clavijo *et al.*	CS / Level 4	7	50.1 (40–60.5)	TP / TV	dV-MP	205 (120–300)	298 (60–800)	1.4 (1–2)	7 (6–9)	Introduces a novel intrafascial enucleation technique that minimizes capsular damage and enhances hemostasis.
Leslie *et al.*	CS / Level 4	25	149 (91–260)	TP / TV	dV-MP	214 (165–345)	143 (50–350)	4 (2–8)	9 (7–23)	Reports initial experience with robotic TV access combined with a Y-V bladder neck plasty to avoid stenosis.
Pokorny *et al.*	RC/ Level 4	67	129 (104–180)	TP / TV	dV-MP	97 (80–127)	200 (115–360)	4 (3–5)	3 (2–4)	Confirms outstanding functional and symptom relief (LUTS/BPE) in a high-volume robotic center.
Castillo *et al.*	CS / Level 4	34	117 (99–146)	TP / TV	dV-MP	96 (78–126)	200 (100–300)	2.2 (1–4)	4.6 (4–6)	Employs a modified running vesicourethral anastomosis that minimizes urinary leak rates and macrohematuria.
Falavolti *et al.*	CS / Level 4	185	100 (80–195)	TP / TV	dV-MP	205 (120–300)	220 (100–350)	3.2 (2–6)	5.6 (5–7)	Proposes temporary internal iliac artery clamping to safely control and dramatically lower intraoperative EBL.

Table 1 continued.

Study	Design / LoE	N	Prostate volume (mL)	Approach/ technique	Robot type	Operative time (min)	EBL (mL)	LOS (days)	Catheter duration (days)	Key finding
Chavali *et al.*	CS / Level 4	28	180	TP / TV	dV-MP		200		8	Provides critical surgical technical hints for transvesical RASP to ensure efficient and clean adenoma enucleation.
Cacciamani *et al.*	CS / Level 4	23	108 (67–149)	TP / TV / CMA	dV-MP	160 (132–192)	98	2.1		Evaluates a 360 circumferential reconstruction technique after TV enucleation.
Wang *et al.*	CS / Level 4	27	82 (75–92)	EP / US	dV-MP	169 (159–185)	235 (180–300)	3 (2–4)	1 (1–2)	Reports successful extraperitoneal urethra-sparing RASP, preserving the urethral tract and accelerating recovery.
Simone *et al.*	CS / Level 4	12	102 (88–115)	TP / US	dV-MP	150 (145–170)	250 (200–350)	3 (2–3)	7	Utilizes ICG near-infrared fluorescence to guide a modified Madigan technique, preserving the urethra and ejaculation.
Lee *et al.*	RC / Level 3b	150	145 (80–210)	TP / TV / CR	dV-MP	169 (110–228)	294 (63–525)	1.4 (1–2.7)	7 (5–9)	Demonstrates excellent intermediate-term durable urinary function improvement with low long-term complications.
Carbonara *et al.*	CS / Level 4	1	990	TP / TV	dV-MP	240	1000	4	10	Confirms technical feasibility of standard transperitoneal RASP for extreme "giant" BPH pathology.
Shahait *et al.*	CS / Level 4	30	97 (74–148)	TP / BNS	dV-MP	107 (85–129)	132 (87–167)	1		Shows that BNS technical modification drastically lowers early incontinence and contracture rates.
Kam *et al.*	CS / Level 4	11	129 (64–195)	TP / TV (Post-PAE)	dV-MP				7	Outlines safe initial experience performing salvage RASP following failed PAE.
Porpiglia *et al.*	RC / Level 3	92	140 (119–171)	TP / US	dV-MP	110 (97–122)	200 (110–3000)	5 (4–6)	4 (3–6)	Demonstrates that urethra-sparing RASP effectively preserves antegrade ejaculation function compared to Millin techniques.
Choi *et al.*	RC / Level 3	62	100 (80–120)	EP / US	dV-MP	123 (108–138)	151 (75–227)	2.9 (1.4–3.4)	2.4 (0.7–4.1)	Confirms high rates of postoperative antegrade ejaculation preservation utilizing a dedicated urethra-sparing technique.
Mottaran *et al.*	CS / Level 4	1	155	TP / TV	HUGO-RAS	150		3 (2–4)	2	Demonstrates safety and absolute feasibility of modular multi-cart system using the novel HUGO-RAS platform.

Table 1 continued.

Study	Design / LoE	N	Prostate volume (mL)	Approach/ technique	Robot type	Operative time (min)	EBL (mL)	LOS (days)	Catheter duration (days)	Key finding
Piro *et al.*	CS / Level 4	20	120 (101–154)	TP / TV or RP	HUGO-RAS	165 (121–180)		3 (3–4)	1	Provides step-by-step descriptions of both TV and RP layouts utilizing the modular configuration of the HUGO-RAS.
Novara *et al.*	PC / Level 3	87	150 (125–188)	TP / RS	dV-MP	$175 (140–210)	350 (200–500)	3 (2–4)	5 (3–6)	Validated questionnaires confirm excellent short-term functional recovery and low pain using Retzius-sparing RASP.
Pham *et al.*	CS / Level 4	50	180 (132–228)	TP / TV	dV-Xi	140 (112–168)	274 (94–400)	5.2 (3.3–8.1)	7	Confirms excellent and stable lower urinary tract symptom relief at a medium- to long-term follow-up checkpoint.
Shumaker *et al.*	CS / Level 4	292	156 (78–234)	TP / TV	dV-Xi	164 (110–218)	301 (66–536)	1	7.3 (3.2–11.4)	Largest cohort to date showing superb long-term urinary/sexual outcomes using a circumferential mucosal anastomosis.
Qureshi *et al.*	CS / Level 4	82	133 (106–160)	TP / TV	Versius	160.5 (127–187)	678 (364–992)	4 (2.3–5.7)	7 (4–10)	First study showing successful deployment of the open-console Versius® robotic framework for transvesical RASP.
Johnson *et al.*	RC / Level 4	120	121.5 (102–149.3)	TP / TV	dV-MP	157 (136–180)	Hb drop 5.4%	1 (1–2)	4 (4–6)	Maps the RASP learning curve, demonstrating that efficiency stabilizes after approximately 10–15 cases for robotic surgeons.
Kaouk *et al.*	CS / Level 4	10	159 (108–223)	TP / TV / SP	dV-SP	190 (146–203)	100 (68–175)	0.8 (0.7–1.1)		Initial experience showing that dedicated SP robotic systems allow for same-day discharge (outpatient).
Steinberg *et al.*	RC / Level 3b	10	104 (93–115)	TP / TV / SP	dV-SP	172 (153–191)	141 (43–239)		1.9 (0.1–3.7)	Confirms dedicated single-port extraperitoneal Millin architecture avoids peritoneal space while keeping pain scores low.
Abou Zeinab *et al.*	CS / Level 4	91	156 (94–218)	TP / TV / SP	dV-SP	159 (114–204)	100 (50–200)	0.8 (0.2–1)	5 (5–7)	Large multi-institutional analysis proving dedicated SP-TV approach offers superior postoperative data uniformity.
Abou Zeinab *et al.*	CS / Level 4	42	170	TP / TV / SP	dV-SP			4.6 (4.1–5.7)	7	Focuses on protocol shifts toward accelerated recovery pathways, driving a mean hospital stay under 24 hours.
Ramos *et al.*	CS / Level 4	117	> 80	TV / SP	dV-SP	107	100	1		Demonstrates excellent long-term standard reproducibility of dedicated single-port RASP across 100 cases.

Table 1 continued.

Study	Design / LoE	N	Prostate volume (mL)	Approach/ technique	Robot type	Operative time (min)	EBL (mL)	LOS (days)	Catheter duration (days)	Key Finding
Younis *et al.*	RC / Level 3	179LP: 93 VLP : 86	150 (81–425) LP: 80–150 VLP > 150	TV / SP	dV-SP	LP: 98 (70–120) VLP: 115 (82–143)	LP: 80 (50–100) VLP: 100 (53–150)	LP : 4.6 (3.7–5.9) VLP : 5 (3.8–6)	LP : (4–7) VLP : 5 (3–7)	Compares outcomes across glands 80-150 cc *vs.* > 150 cc, proving single-port STEP remains robust regardless of massive size.
Santodirocco *et al.*	CS / Level 4	130	110 (85 – 153)	TV / SP	dV-SP	191 (152–240)	50 (30–150)	9 h (8–11)		Risk-adjusted CUSUM curves demonstrate the learning curve for specialized single-port RASP optimizes after 20 operations.
Qi *et al.*	RC / Level 3	89	110 (90–171)	TV / SP	dV-SP	180 (164–200)	100 (30–180)	5–9 h		Volume-stratified analysis definitively establishing the safety profile of SP-TV in massive gland dimensions.

Note: LoE, Level of Evidence; CS, Case Series; RC, Retrospective Comparative Study; PC, Prospective Cohort Study; EP, Extraperitoneal Approach; TP, Transperitoneal Approach; TV, Transvesical Approach; SP, Single-Port; RP, Retropubic Approach; US, Urethra-Sparing Technique; BNS, Bladder Neck Sparing Technique; CR, Circumferential Reconstruction; CMA, Circumferential Mucosal Anastomosis; PAE, Prostatic Arterial Embolization; dV-MP, da Vinci Multi-Port Surgical System; dV-Xi, da Vinci Xi Surgical System; dV-SP, da Vinci Single-Port Surgical System; HUGO-RAS, HUGO™ Robot-Assisted Surgery System; Versius, Versius® Robotic System; EBL, Estimated Blood Loss; LOS, Length of Stay; LUTS, Lower Urinary Tract Symptoms; BPE, Benign Prostatic Enlargement; ICG, Indocyanine Green; STEP, Single-Port Transvesical Enucleation of Prostate; CUSUM, Cumulative Summation; LP, Large Prostate (80–150 ml); VLP, Very Large Prostate (>150 ml); Hb drop, Hemoglobin drop; NR, Not Reported.

Kaouk *et al*. present the first series operated by SP percutaneous transvesical simple prostatectomy using the novel SP robotic surgical system. The authors explain that the system enables the surgery to be performed via a single incision containing multiple working channels. They also conclude that this approach avoids the need to access the peritoneum, minimizes dissection of the bladder and provides excellent visualization of the prostatic fossa [64]. Steinberg *et al*. reported similar results in a series of 10 patients who underwent SP-RASP [65]. Abou Zeinab *et al*. present the first multi-institutional collaboration with the largest cohort to date on SP-RASP. The authors included a total of 91 patients who underwent surgery at three institutions, performed by three different surgeons, with operating times of 156 minutes, intraoperative blood loss of 100 mL, minimal pain, and enabling same-day discharge [66]. The same group presented a series of 42 cases of SP-RASP, achieving a hospital stay of less than 5 hours [67]; and when comparing their results with open surgery, they found significant benefits in terms of reduced bleeding, the absence of bladder irrigation, a very short hospital stay and a reduction in the duration of catheterization [81]. Three further robust series on SP-RASP have recently been published, confirming the previously reported findings regarding the benefits of this technique in reducing hospital stays to same-day discharge and its effectiveness in cases involving very large prostates [68, 69, 71] (Figure 1C).

Learning curve of LSP, RASP, and SP-RASP

It is widely accepted that laparoscopic surgery involving reconstructive techniques requires a prolonged learning curve, and this may be one of the limitations when comparing LSP with open surgery. The published evidence for the LSP learning curve is very limited, and there is no consensus on the number of cases required comparable to the laparoscopic radical prostatectomy [30].

In relation to the learning curve for RASP, it is known that urologists with prior experience in robotic surgery find it easier to train in and acquire this technique. It is also well known that one of the major benefits of robotic surgery is the reduced learning curve compared with laparoscopic techniques. At present, the scientific literature on the RASP learning curve is very limited. Johnson B. *et al*. performed a retrospective study of 120 cases of RASP with the aim of defining the learning curve. The authors reported in their study that the assessment of the learning curve depends on the parameters selected for analysis, and concluded that blood loss and tissue yield showed the greatest improvement over time, but neither showed significant improvement beyond 12 cases, enabling them to estimate a learning curve of between 10 and 12 cases for experienced robotic surgeons [60].

Proficiency for SP-RASP was reached at 33 cases, and technical consolidation occurred after approximately the 75th case, based on risk-adjusted CUSUM (RA-CUSUM) of operative time in a single-surgeon series of 103 consecutive cases. In the learning curve of SP-RASP, the prostate volume is the dominant driver of operative duration, with BMI also contributing [70].

Comparative proficiency and mastery difficulty across the three surgical approaches

OSP versus RASP

There are numerous comparative studies between OSP and RASP. In all of them, the findings highlight the benefits of robotic surgery in terms of reduced bleeding, lower transfusion rates, and a lower incidence of perioperative complications, shorter hospital stays, shorter catheterization times and lower readmission rates. In contrast, the robotic approach involves longer operating times, represents a higher institutional cost and requires experience in robotic surgery.

Finally, comparative studies confirm that OSP and RASP provide equivalent functional outcomes in terms of Q_{max}, IPSS, quality of life and the volume of prostate tissue removed [72-80].

RASP (MultiPort versus Single-Port)

To our knowledge, there are only two studies comparing RASP performed using a multi-port (MP) approach versus the single-port approach. Khalil *et al*. presented a comparative study of MP- and SP-RASP involving a total of 75 patients, 45 of whom underwent MP surgery and 28 single-port surgery. The results report for MP *vs*. SP with regard to operative time (216.6 min *vs*. 232.4 min), blood loss (195.7 mL *vs*. 227 mL), hospital stay (2 days *vs*. 2.5 days) and duration of urinary catheterization (10.2 days *vs*. 10.5 days). Based on these findings, the authors concluded that the procedures are equivalent [84].

In the Abou Zeinab's *et al* study a total of 405 patients were included, 240 underwent surgery using the MP approach and 156 using the single-port approach. The authors reported less blood loss, a brief hospital stay, a shorter catheter indwelling time and a lower requirement for opioids with the single-port system [85].

RASP (Transvesical *vs*. Transcapsular)

Farzat *et al*. conducted a comparative analysis of perioperative outcomes between transvesical RASP and robot-assisted transcapsular RASP using a multiport system in a series of 100 patients, 40 of whom underwent surgery via a transvesical approach and 60 via a transcapsular approach. The authors reported that the transcapsular technique resulted in shorter console time (71 min *vs*. 91 min), shorter bladder catheterization time (4.3 days *vs*. 6.7 days) and a shorter hospital stay (5 days *vs*. 6 days). On the other hand, they concluded that although the transvesical technique resulted in more complications, but it represents the most appropriate option for complex cases. However, the choice of approach depends on the surgeon's preference and experience [82].

Comparative safety and efficacy between LSP and RASP

Autorino *et al*. presented a retrospective, multicenter analysis across 23 European and American institutions that evaluated 1,330 surgeries, including 487 RASP and 843 LSP. In descriptive comparisons, median operative time was 95 minutes for LSP versus 154.5 minutes for RASP; median length of stay was 4 days for LSP versus 2 days for RASP; median time to catheter removal was 4 days for LSP versus 7 days for RASP; and ≤ 90-day complication rates were 7.1% for LSP versus 16.6% for RASP. At approximately 12 months of follow-up, no differences in functional outcomes were reported. The study concluded that LSP and RASP are feasible, safe, and effective surgical options for bladder outlet obstruction due to benign prostatic enlargement. The authors stated that robotic technology may be a reasonable option in institutions with an established robotic platform for other common urologic procedures [86].

Pavan *et al*. presented a retrospective, multicenter comparative study that evaluated 319 consecutive patients, comparing LSP (*N* = 189) with RASP (*N* = 130) and assessing both perioperative and functional outcomes. The results were similar without statistical significance in operative time (150 *vs*. 120 min), estimated blood loss (250 *vs*. 300 mL), complications (3.8% *vs*. 5.3%), catheterization time (median 5 *vs*. 5 days), and length of stay (median 5 *vs*. 5 days). Postoperative morbidity showed a higher complication rate after RASP (17.7% *vs*. 5.3%), driven by minor (Clavien 1–2) events (14.7% *vs*. 3.2%). Both procedures produced significant functional improvement. The authors conclude that both LSP and RASP are safe and effective minimally invasive options for large prostates [87].

Martín-Garzón *et al*. presented a prospective, nonrandomized, unblinded, study that compared outcomes of LSP (*N* = 82), RASP (*N* = 79), and Intrafascial-RASP (*N* = 75). The authors reported operative time around 152–162 minutes and no significant differences in estimated blood loss or transfusion rates; overall complication rates were similar across groups. At 12 months, continence rates were high and not significantly different (97.4% LSP, 94.4% RSP, 95.8% Intrafascial-RSP). The authors concluded that Intrafascial-RASP is safe and effective, with outcomes comparable to LSP and RASP, no need for postoperative irrigation, and potentially more complete tissue removal with increased detection of occult cancer [88].

Amenta *et al*. presented a retrospective comparative study that analyzed 25 cases of LSP and 25 RASP. The authors concluded that RASP is safe and yields perioperative and functional outcomes comparable to LSP, with advantage of a shorter hospitalization, while emphasizing that given the higher costs and limited availability of robotics platforms, LSP is a safe alternative in the hand of an experienced surgeon [89].

Li *et al*. published a systematic review and meta-analysis that compared LSP with RASP by pooling five comparative studies comprising 1928 patients (1175 LSP and 753 RASP). In pooled analyses, RASP was associated with a shorter length of hospital stay (1.20 *vs*. 2.32 days), whereas operative time, estimated blood loss, catheterization time and overall complications were not significantly different between approaches. Functionally, RASP demonstrated a higher Q_{max} in pooled analysis.. The authors concluded that LSP and RASP provide overall comparable efficacy and safety for large-gland BPH, with RASP showing a more favorable perioperative/functional profile driven mainly by shorter hospitalization and modestly higher Q_{max} [90].

Pandolfo *et al*. performed a systematic review and meta-analysis to compare the perioperative safety and effectiveness of RASP versus open simple prostatectomy (OSP), LSP, and laser endoscopic enucleation of the prostate. Fifteen comparative studies were included, totaling 6659 patients. In pooled comparisons with OSP, RASP was associated with significantly longer operative time but lower estimated blood loss, lower transfusion rate, shorter length of stay, and lower postoperative complication rate, supporting a perioperative morbidity advantage for the robotic approach relative to open surgery. RASP can duplicate the functional outcomes of OSP while offering a better safety profile. When compared to LSP, the latter still stands as a valid lower-cost option, but it requires

Table 2. Baseline characteristics and perioperative outcomes of RASP versus LSP.

Author	Study	*N*	Prostate size (mL)	Operative time (min)	Blood loss (mL)	Length of stay (days)	Complications	Key finding
Autorino *et al.*	Retrospective Multicenter	*N* = 1330 (RASP = 487 LSP = 843)	RASP : 110 LSP : 99	RASP : 154 LSP : 95	RASP : 200 LSP : 280	RASP : 2 LSP : 4	RASP: 16.6 LSP: 7.1	Trifecta outcome not influenced by approach
Pavan *et al.*	Retrospective Multicenter	*N* = 319 (RASP = 130; LSP = 130)	RASP: 118; LSP: 109	RASP : 150 LSP : 120	RASP : 250 LSP : 300	RASP : 5 LSP : 5	RASP : 17.7 LSP : 5.3	Both approaches safe and effective
Martín Garzón *et al.*	Prospective nonrandomized Single center	*N* = 236 (RASP = 79; LSP = 82 IF-RASP = 75)	RASP : 80.3 LSP: 80.6 IF-RASP : 75.5	RASP : 162.3 LSP: 161.2 IF-RASP: 152.2	RASP : 390 LSP : 331 IF-RASP : 535	-	RASP: 12.6 LSP: 14.6 IF-RASP: 10.6	IF-RASP technique is safe and effective, does not require irrigation, ability to detect prostate cancer
Amenta *et al.*	Retrospective Two center	*N* = 50 (RASP = 25; LSP = 25)	RASP : 135 LSP : 141	RASP : 139 LSP : 122	RASP : 150; LSP : 150	RASP : 4 LSP : 6	RASP : 16 LSP : 8	RASP comparable safety; shorter LOS, longer OT

solid laparoscopic skill sets and therefore it is unlikely to spread on larger scale [91]. The results of this series are summarized in the Table 2.

Discussion

Banapour *et al*. conducted a systematic review of RASP and reported an additional single-institution case series. The review included eight non-comparative case series published between 2008 and 2012, comprising 109 patients, and 16 additional cases, for a total of 125 patients. Mean operative time ranged from 128.8 to 211 minutes, estimated blood loss varied from 50 to 558 mL, with a mean of 197 mL in the institutional series. The mean weight of the resected adenoma ranged from 46.4 to 301 g, Catheterization duration ranged from 4.6 to 13 days, and hospital stay ranged from 1 to 6 days, with more than 75% of studies reporting a length of stay shorter than 3 days; the median hospital stay was only 1 day. Transfusion rates were 0% in most published series. Complication rates were low. Functional outcomes showed substantial improvement in lower urinary tract symptoms, with postoperative IPSS scores decreasing from preoperative values of 17.8–24 to postoperative values of 5–8.1. Overall, the authors concluded that RASP is a safe and effective treatment for patients with large-volume benign prostatic hyperplasia, offering reduced blood loss, minimal transfusion requirements, short hospitalization, and excellent functional outcomes [92].

Kordan *et al*. performed a systematic review of the literature on RASP, including 35 studies published between 2008 and February 2020, comprising 26 non-comparative case series and 9 comparative studies. A total of 1,564 patients underwent RASP across the included studies. The overall level of evidence was III, as no randomized controlled trials were available. Mean prostate volume ranged from 70.9 to 323 mL. Operative time varied between 90 and 274 minutes, while estimated blood loss ranged from 98 to 558 mL. The weight of the resected adenoma ranged from 46.4 to 301 g. Mean catheterization time varied from 1.6 to 13 days, and length of hospital stay ranged from 1 to 8.8 days. Transfusion rates were generally very low, with most series reporting no transfusions. Overall complication rates ranged from 0% to 37.5%, with most complications being minor. Functional outcomes demonstrated substantial improvement after surgery. The authors concluded that RASP is a safe and effective treatment option for prostates larger than 80 g, providing excellent functional outcomes with low transfusion rates, acceptable morbidity, reduced blood loss, and shorter hospitalization compared with open simple prostatectomy, although at the expense of longer operative times [93].

Moschovas *et al*. conducted a comprehensive non-systematic literature review evaluating the evolution of RASP techniques. The review included 16 original studies published between 2008 and 2020, encompassing approximately 255 patients treated with various RASP approaches. The available evidence consisted primarily of retrospective case series, corresponding to Level IV–V evidence. Mean prostate volume ranged from 47.5 to 301 mL. Operative time varied from 90 to 241 minutes, estimated blood loss ranged from 98.6 to 584 mL, hospital stay ranged from 0.8 to 8.4 days, and catheterization duration varied between 1 and 15 days. Transfusion rates ranged from 0% to 33%, although most contemporary series reported no need for blood transfusion. Functional outcomes demonstrated substantial improvement in lower urinary tract symptoms. The authors concluded that robotic-assisted simple prostatectomy has undergone considerable technical evolution since its first description and currently represents a safe, effective, and minimally invasive surgical option for patients with large-volume benign prostatic hyperplasia, offering favorable perioperative outcomes while preserving excellent functional results [94].

Xu *et al*. presents a narrative review of RASP. The authors concluded that RASP is a safe minimally invasive option with a shorter learning curve for surgeons already experienced in robotic surgery, with low rates of severe morbidity, offering outcomes comparable to OSP, shorter catheterization. However, the evidence base remains dominated by nonrandomized studies, and well-designed prospective randomized trials with long-term follow-up are still needed to confirm durability and optimize technique selection [95].

Finally, the answer to the initial question: which is better, LSP or RASP? In reality, both procedures are minimally invasive approaches, meaning that their benefits in terms of reduced morbidity and less pain are comparable, but several issues must be explained. Firstly, regarding learning curve, laparoscopic surgery requires more complex and prolonged learning curves to acquire surgical skills, compared to robotic surgery since this platform helps to assist novice surgeons, simplifying movements and reducing learning curve. RASP has proven clear benefits. In fact, robotic surgery training does not depend strictly on the operator's innate skills, but rather on the availability of the robotic system at their centre and the administrative selection process that allows surgeons to access to it.

Secondly, optimal visualization of surgical field and meticulous tissue dissection is superior in robotic surgery, as reported by authors according to available scientific literature. This is particularly important in oncological surgeries such as radical prostatectomy, where functional outcomes depend entirely on the quality of the procedure. However, in simple prostatectomy, this does not appear to be as relevant because the surgical aim is to relieve obstruction, as results are equivalent to those of OSP. The major benefit of RASP lies in the reconstructive steps, demonstrating advantages of this technique in terms of reduced morbidity and shorter catheterization times related to urethro-vesical anastomosis, including optimization of urethral preservation techniques and the approach preserving the Retzius space. These techniques are less feasible in laparoscopic surgery.

Thirdly, single-port technique–which has been greatly advanced by development of robotic platforms specifically designed for this approach–allows for maximum minimally invasive surgery through transvesical techniques using pneumovesicum, and also enables creation of 360-degree anastomoses. This approach eliminates the need for irrigation minimising the need for hospitalization. This technique is not possible using laparoscopy. The limitation lies in the widespread use of SP platforms.

Cost wise, there are no comparative cost studies between RASP and LSP. No robust published economic evaluations directly comparing costs of RASP *vs*. LSP are present in the provided evidence set. All cost-effectiveness/cost studies supplied are for robotic *vs*. laparoscopic radical prostatectomy or other oncologic surgery and therefore cannot be extrapolated to simple prostatectomy costs (different indications, pathways, OR time, LOS, complication mix, disposables). The cost of robotic technology in RASP is likely still the breaking point, as a strict analysis of the equipment and instruments shows them to be significantly more expensive than LSP or OSP. However, a more detailed analysis that takes into account the savings achieved through shorter hospital stays, fewer complications, fewer readmissions and reduced use of irrigation can change this balance. Furthermore, cost analyses vary widely depending on healthcare policies across different countries and between private and public centers.

In the EAU and AUA guidelines, the Holmium Laser Enucleation of the Prostate (HoLEP) is recognized as a standard for the treatment of BPH and is most versatile minimally invasive surgical technique for large prostate [1, 2]. But in contrast to RASP, HoLEP and others LEP are technically difficult procedures with a learning curve of 40–60 cases and variability in performance even late in the surgeon's experience [96-98]. Numerous studies have compared the outcomes of RASP with HoLEP and show that the functional outcomes are equivalent, demonstrating advantages for LEP over RASP in terms of shorter operating times, less intraoperative bleeding, lower transfusion rates, and shorter hospital stays, although with a steep learning curve [99-103]. The reality is that implementation of robotic technologies is expanding worldwide and their applicability is becoming increasingly widespread in multiple surgeries; on the other hand, the applicability of laser treatment is limited to surgery for BPH and stone disease. Furthermore, RASP makes it possible to treat concomitant diseases during the same surgical procedure, such as bladder stones, bladder diverticula, inguinal hernias, *etc*.

Consequently, when it comes to the question of which is better, the evidence and current trend favour RASP over LSP, without disregarding the benefits of the HoLEP technique.

Future developments may focus on the development of new, lower-cost robotic platforms adapted to the single-port technique, thereby enabling wider adoption, alongside development of more versatile and simplified trocars for this technique. Similarly, telesurgery could be applied to robotic techniques for BPH once its applicability has been standardized and simplified, while laparoscopy and laser techniques will be excluded from this approach.

Conclusions

The RASP and LSP techniques are essentially equivalent in terms of perioperative aspects and functional outcomes; however, RASP may simplify the learning curve, enables significant refinements in surgical techniques and lead improvements in perioperative morbidity. Comparative studies of these techniques are needed to assess the cost-effectiveness of both.

Declarations

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