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Evaluation of urinary and sexual outcomes following bipolar transurethral enucleation versus resection of the prostate

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Abstract
Benign prostatic hyperplasia (BPH) remains a prevalent urological condition in aging males, frequently necessitating surgical intervention when medical management fails. Transurethral resection of the prostate (TURP) is now regarded as the "gold standard" for the surgical management of symptomatic BPH since it removes the intravesical obstruction and improves voiding parameters and symptoms. The principal of this endoscopic surgery and some of the subsequent consequences, such as the high rate of postoperative recurrence, remain unchanged, despite the advancements made in TURP surgical equipment, necessitating a significant innovation in the surgical technique. One potential alternate treatment for BPH is bipolar transurethral enucleation of the prostate (B-TUEP). In conjunction with a bipolar resection sheath, this procedure calls for the utilization of a modified B-TUEP electrode and the conventional bipolar electrosurgical device. The goal of this procedure is to increase the advantages of bipolar electrocautery and the superiority of enucleation over resection. B-TUEP has been shown to produce superior urinary functional outcomes in recent comparative trials and observational studies, as evidenced by significant improvements in maximal urinary flow rates, international prostate symptom scores (IPSS), and reductions in post-void residual volumes. These benefits can be attributed to the whole anatomical resection of adenoma in enucleation, which more closely approximates open prostatectomy while minimizing invasiveness. Both techniques are associated with the risk of postoperative sexual dysfunction, particularly retrograde ejaculation. However, B-TUEP may have a slightly higher incidence as a result of the more extensive resection in the near ejaculatory ducts.

Keywords: Urinary, Sexual, Outcomes, Bipolar Transurethral Enucleation, Resection of the Prostate

Introduction
Benign prostatic hyperplasia (BPH) is a common condition that affects men with aging. Approximately 50% of males have been diagnosed with BPH by the age of 50. The highest prevalence is observed among males aged 70 to 79, and 90% of men have been diagnosed by the age of 80. The proliferation of prostatic cells in BPH exacerbates symptoms of the lower urinary tract, urethral obstruction, and prostate hypertrophy. Recurrent urinary tract infections (UTIs) and renal failure are potential complications that may be experienced by men with BPH, as well as significant irritation during urination. Healthcare providers are required to be capable of identifying and treating BPH, as the prevalence of the disorder is anticipated to increase as a result of the an aging population [1].

Risk factors for BPH
Obesity, a family history of BPH, metabolic syndrome, functioning testicles, black race, and an increasing age are all common risk factors for BPH. BPH progression may be affected by a patient's diet, nicotine intake, and exercises. Patients who eat a diet that is heavy in vegetables are expected to experience less severe symptoms of BPH than those who do not, even though the consumption of fruit has not been demonstrated to have a comparable significant relationship with the severity of BPH. An elevated risk of developing BPH has been linked to a diet rich in carbohydrates and proteins. Furthermore, it was demonstrated that heavy alcohol consumption can exacerbate the risk and progression of BPH. Even though smoking may be a risk factor, the establishment of a relationship between smoking

and BPH is impeded by conflicting evidence [2]. In patients who already have BPH, an inactive lifestyle can exacerbate the severity of lower urinary tract symptoms or increase the risk of developing the condition, according to prior research. The integration of physical activity and exercise into daily routine is crucial, as it can aid in the prevention of both BPH and metabolic syndrome, which are closely associated with BPH. Additionally, the treatment of BPH is more cost-effective when implemented through physical activity than through pharmacologic or surgical interventions. Clinicians and patients must be aware of the factors that contribute to the progression of BPH upon diagnosis, such as advanced age, severe lower urinary tract symptoms, elevated prostate-specific antigen (PSA) levels, and large prostates [3].

Clinical manifestations

Storage and voiding are the two primary categories into which the symptoms of BPH can be classified. Initially, men may exhibit a limited number of these symptoms; however, as they age and the disease advances, they may become more prevalent. The quality of life is frequently impaired by the distressing and bothersome symptoms that patients with BPH frequently report [4].

Diagnosis

- **Symptoms**

a) Men with BPH may experience storage LUTS, which are characterized by urgency, frequency, nocturia, and intermittent incontinence. These symptoms are most frequently caused by bladder overactivity.
b) Incomplete evacuation or straining, hesitancy, and a week stream (voiding LUTS).
c) Symptoms of UTI such as bloody urine or painful urination.
d) Inability to urinate (urinary retention) [5].

Transurethral resection of the prostate

In TURP, two varieties of electrosurgery circuits are employed: monopolar and bipolar. Depending on the location and distance between the active and return electrodes, the current pathway configuration differs between the two circuits. The active electrode's release of electrons, which overcomes tissue resistance, results in the desired tissue effect (heat production) in both circuits [6].

- **Bipolar TURP**

The active and return poles are integrated using the same electrode in bipolar electrosurgery. In contrast to monopolar electrosurgery, which requires energy to complete the circuit between the two poles at the site of surgery (site of prostate resection), bipolar systems require less energy and, more importantly, less voltage to complete the circuit. This is due to the relatively lower tissue and less encountered resistance. The advanced bipolar systems incorporate the tissue impedance monitoring during each resection and the adjustment of the power and voltage transmitted to reduce tissue trauma [7].

The current is maintained at the resection site during B-TURP, and it is not required to pass through the patient to a return electrode (in the form of a grounding pad). The risk of TUR syndrome has been significantly reduced by the ability to conduct the resection in a standard ionic irrigating solution (normal saline), which has also been facilitated by this design innovation. The first energy transfer from the loop to the surrounding saline is known as plasma kinetic technology. When a voltage of about 300 V rms is introduced into the gas layer surrounding the loop, sodium ions exit, resulting in the plasma production. The saline is subsequently transformed into gas. The plasma's agitated sodium ions are responsible for the distinctive orange glow of this technology (Figure 1) [8].

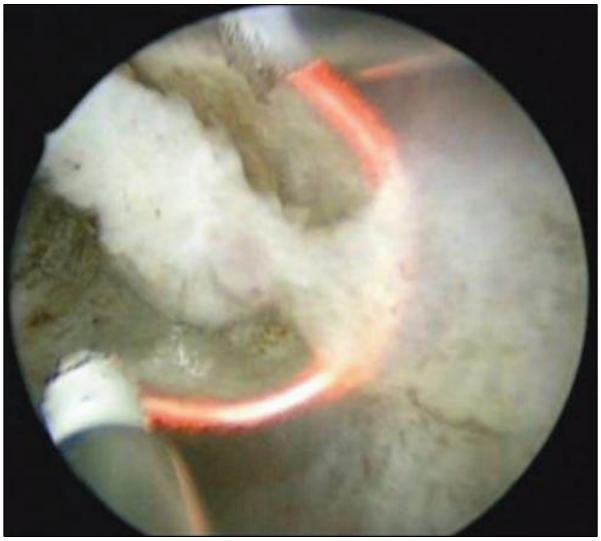

Fig 1: The bright orange appearance of the energized plasma layer surrounding the active electrode resection loop (Gyrus Plasma Kinetic System) [9]

Following its generation, plasma molecules are now capable of being excited for resection. It allows for tissue resection at lower temperatures and with a lower voltage, although it may appear to be a dynamic and intense process. This mechanism leads to an overall enhancement in hemostasis via enabling the simultaneous tissue cutting and vessels sealing. The Plasma Kinetic bipolar system's coagulation mechanism is wholly distinct from that of resection. In order to prevent plasma formation, a low voltage of approximately 120 Vrms is maintained, despite the fact that the initial heating effect remains consistent with the previously described pattern [10].

The current is unable to cross the high gas interface impedance in this process, resulting in only tissue-resistive heating. The process results in the dissipation of energy as heat within the vessel walls, and the tissue and blood combine to form a coagulum, which effectively seals the bleeder. The white blanching of tissue during coagulation is a sign of the development of coagulum and peripheral collagen contraction, in contrast to the orange brilliance of energized plasma that is associated with cutting. In contrast to monopolar coagulation, which involves high voltage and extreme temperatures, the PK bipolar system utilizes lower voltage and temperatures to mitigate the amount of charring and blackening in the tissue (Figure 2) [11].

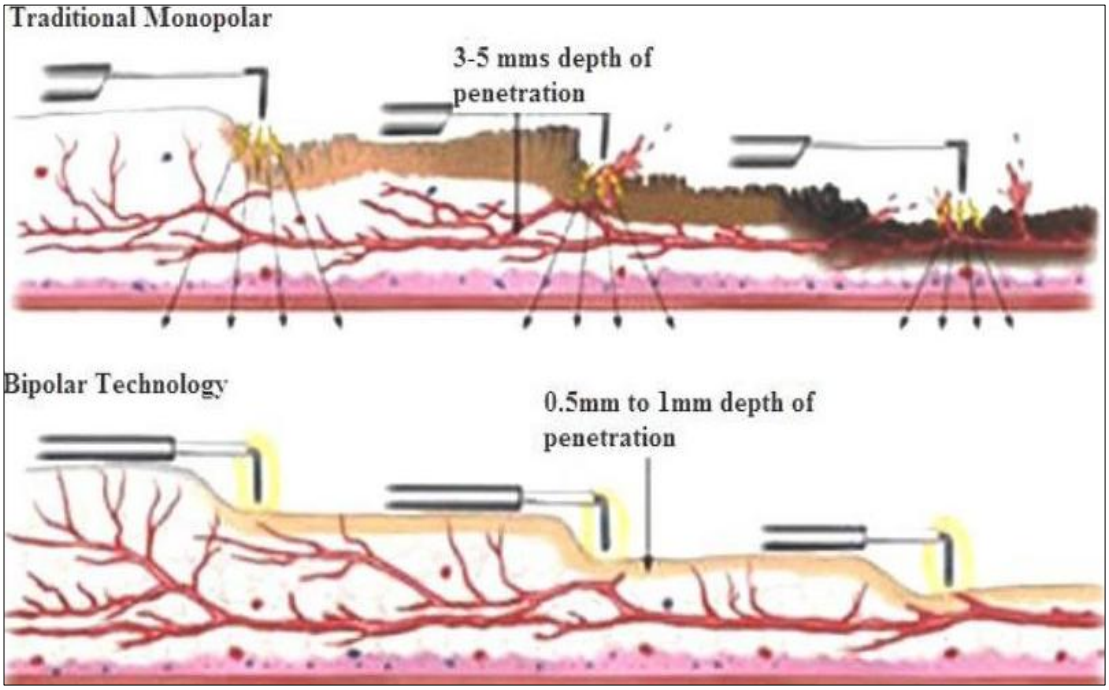

Fig 2: Minimal tissue trauma with PK TURP due to lower voltage. Different manufacturers (i.e. Gyrus, VISTA-ACMI, Olympus, Karl Storz) introduced bipolar devices which have minor technical differences in delivering bipolar current flow to achieve the plasma effect as they differ in the arrangement of the active and passive electrode [12]
]

The clinical efficacy of bipolar transurethral resection of prostate

Bipolar-TURP (B-TURP) has a more benign perioperative safety profile than monopolar- TURP (M-TURP), but both provide similar short-, mid-, and long-term outcomes [13].

In a previous systematic review and meta-analysis, Huang *et al.* [14] determined that B-TURP had superior efficacy and lower complication rates compared to M-TURP. In contrast to laser systems, the bipolar energy generator is multifunctional. It is an energy system that is both prospective and advantageous in developing countries, particularly for BPH surgery. B-TURP had comparable efficacy outcomes in the short term, with a lower rate of complications than M-TURP in patients with a prostate volume of less than 80 ml. Furthermore, it demonstrated prospective benefits in patients who were at a high risk of bleeding and a decreased complication rate [15].

The complications of bipolar transurethral resection of prostate [16, 17]

a) Haemorrhage is considered one of the more frequent major consequences of TURP either during the procedure (0.2 - 2 % risk for blood transfusion) or postoperative.
b) Clot retention may occur in case of recurrent or persistent bleeding (2%)
c) Retrograde ejaculation should be looked at as an inevitability, not as a complication of TURP
d) Up to 30-40% of patients may experience early incontinence; however, less than 0.5% of patients experience late iatrogenic stress incontinence. Patients also may experience incontinence due to detrusor overactivity (DO) because of longstanding bladder outlet obstruction. DO may cause urinary urgency, frequency, and urge incontinence following TURP which can be pharmacologically managed.
e) Infection is a postoperative complication that may occur due to preoperative bacteriuria, long preoperative stay, and long duration of the procedure (1.7%).
f) Urinary retention after catheter removal may occur. Rather than incomplete resection (3%), primary detrusor failure is the main cause.
g) Urethral strictures, which manifest as meatal stenosis, are typically the result of an inadequate lubrication or an inappropriate relationship between the instrument's size and the urethral meatus's diameter (2.2%-9.8%). Furthermore, bladder neck contracture typically arises following the resection of smaller organs (<30 g) (0.3%-9.2%).
h) Theoretically, erectile dysfunction can occur due neurovascular bundles damage by high-frequency generated current close to the capsule (14%)
i) When large mid-lobes are resected, the ureteral orifice may be challenging to identify, resulting in an uncommon complication known as ureteric orifice injury.

j) Rectal injury can rarely occur after TURP as in patients who have had radiation therapy to the rectum.

Bipolar transurethral enucleation of the prostate

The standard bipolar electrosurgical apparatus and the bipolar resection sheath, in conjunction with a modified B-TUEP electrode, have been employed to develop bipolar transurethral enucleation of the prostate (B-TUEP) as an alternative treatment for BPH (Figure 3). In comparison to the holmium laser enucleation of the prostate, it was discovered that transitioning from the conventional TURP (the most performed) to B-TUEP was simpler. Additionally, the conversion of a B-TUEP procedure to TURP would be more straightforward in the event of nonprogress or complications during the initial learning curve, which would result in a lower initial investment [18].

Once the prostate has been fully enucleated and pushed into the bladder, a tissue morcellator is used to remove the prostatic hyperplastic tissue [19]. The duration of the morcellation procedure is dependent on the prostate size. The morcellator action can be succinctly described as "suck-cut out." Nevertheless, certain studies have documented the "beach ball" or "crazy ball" effect, which is characterized by small, spherical tissue fragments that may persist after morcellation and are challenging to morcellate due to their potential to dislodge from the morcellator blades. The most severe potential complication that may occur during this procedure is an accidental bladder injury or bladder perforation. The morcellator's necessity can be reduced by retaining the enucleated lobes at the bladder neck, resected into small sections, and evacuated in order to reduce costs [20].

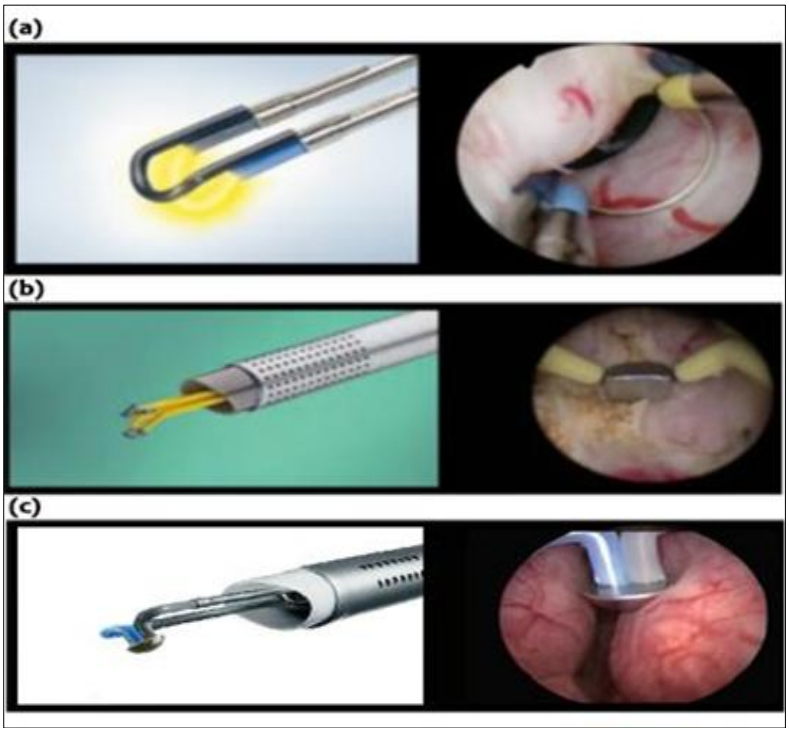

Fig 3: Different type of loop for bipolar enucleation of prostate (a) Plasma enucleation angled electrode (b) Herrmann bipolar vapor-enucleation electrode (c) Bipolar button (mushroom-like) electrode [21]

Along the plane of the adenoma, B-TUEP is the enucleation method. Improved hemostasis is achieved through the early diathermy of the perforating vessels that supply the adenoma, which is particularly evident during the resection of large volume prostate glands. Nevertheless, it is important to consider that a surgeon with a greater level of experience may be necessary when operating on a large gland weighting over 100 g, as the procedure may lead to their disorientation due to the proliferation of potential spaces. As a result, the patient who is new to the enucleation technique should have a moderate prostate weighting 40-80 g. In contrast, the identification of the appropriate surgical plane is challenging when dealing with a minor prostate adenoma, as it may not be optimal due to the presence of prostatitis [18].

When comparing perioperative data between endoscopic enucleation of the prostate (EEP) and endoscopic non-enucleation (ENE) surgeries, both demonstrated effective results, as indicated by a systematic review and meta-analysis. Nevertheless, there was a significant disparity in favour of EEP with respect to the duration of hospital stay and catheterization time, albeit with a longer surgical time [22]. It was reported that the B-TUEP had a significantly reduced rate of blood loss and blood transfusion in comparison to the B-TURP. A reduction in bleeding results in a shortened catheterization time and less bladder irrigation, which in turn leads to a shorter postoperative hospital stay [23].

- **Complications**

Capsular perforation generally occurs as the procedure is carried out in the plane between the prostate adenoma and the surgical capsule. Although carrying into the adenoma in this area will cause bleeding, any trial to the other side will lead to capsular perforation (0.3 - 10%). Morcellator mediated bladder injury can occur. Although these injuries are generally superficial, the possibility of deeper and more significant injury is certainly possible as the morcellator engages tissue indiscriminately (0.5 - 18.2%). Malfunction of the morcellating device or poor hemostasis leading to obscured vision that may lead to postponed morcellation [24].

Similar to TURP injury to the ureteral orifice, transient urinary incontinence, bladder neck contracture, urethral stricture due to large diameter instruments used during the procedure, retrograde ejaculation and injury to the ureteric orifices may occur [25].

- **Enucleation and efficacy**

Clinical BPH-related voiding dysfunction has a detrimental impact on the quality of life of patients and may significantly disrupt their daily routines. At the same time, patients with BPH experience storage symptoms that are also distressing. After a surgical procedure for clinical BPH, the degree of de-obstruction may affect the rehabilitation of detrusor function. The risk of capsular perforation and severe venous hemorrhage frequently prevents the TURP procedure from being performed at the capsule's fiber level. Consequently, an accumulation of adenoma tissues persists following TURP, which typically leads to a high postoperative recurrence rate. A significantly larger percentage of tissue was removed after enucleation in a study than in traditional TURP, with 74.7% of the tissue being removed. This led to a significant enhancement in postoperative IPSS, QoL, and Qmax [26].

- **Enucleation and PSA**

In clinical BPH, the size of the adenoma in the transitional zone reflect on the elevated PSA level, therefore, the PSA level should decrease significantly in cases where the adenoma is thoroughly removed. A randomized trial demonstrated that the enucleation group and the open surgery group experienced a comparable reduction in postoperative prostate volume and PSA levels during 1-year follow-ups [27]. The enucleation group had a significantly lower postoperative PSA level and a reduction in the mean PSA level than the TURP group. These findings, in conjunction with the comparable findings of other studies, indicate that a higher peak urinary flow and a lower PSA level may serve as surrogate markers for a more thorough adenoma excision. The majority of patients who had TUERP at the authors' facility, according to the long-term follow-up data, continued to have a steady PSA level between 0.41 and 1.08 [28]. Moreover, a currently examined concept revealed that an anomalous elevation in PSA levels should serve as an indicator of potential prostate cancer inside the remnant prostate gland. The PSA level is believed to be a helpful tool for the early diagnosis of prostate cancer and an indication of the amount of adenoma excision in cases where there is a prolonged increase following prostate enucleation [29].

- **Enucleation and complications**

In 8% of patients who underwent endoscopic resection with bipolar energy, capsular perforation or bladder neck undermining was reported. It was hypothesized that the enucleation was performed in the natural plane between the gland and surgical capsule, and it was associated with the specified procedure. With the perforating arteries that run along the inside of the surgical capsule and the arterial network that escaped the prostatic adenoma, endoscopic supervision makes the hemostasis process simple. In order to help maintain the bladder neck's physiological gradient during the procedure, the surgical plane is positioned precisely. This in turn contributes to the preservation of uncompromised sexual and urinary functions in the postoperative period (Figure 4) [21].

An overactive bladder and urinary tract infection were among the factors that were associated with transient urinary incontinence, which was experienced by 9.4% of the patients within one month of surgery. In addition, 7.7% of the patients experienced transitory urinary retention. In 7.7% of the patients, transitory urinary retention was observed. After three months, the majority of patients who experienced urge incontinence or temporary incontinence were able to recover, and any issues related to the surgery were resolved without the need for additional care. In order to treat bladder neck contracture and urethral stricture, the rate of urethral dilatation and/or urethrotomy was similar to that of endoscopic resection (7.7%) [30].

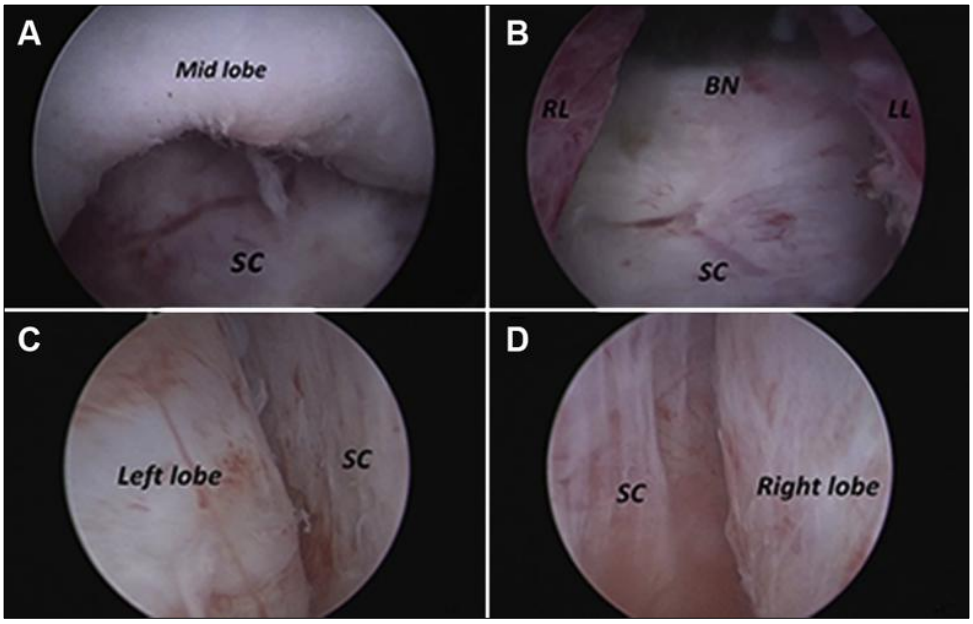

Fig 4: Enucleation based on the surgical capsule. (A) Enucleation of the middle lobe; (B) Preserving the physiological gradient of the bladder neck (after enucleation of the middle lobe); (C) Enucleation of the left lobe; (D) Enucleation of the right lobe; SC, surgical capsule; BN, bladder neck; RL, right lobe; LL, left lobe [24]

- **Enucleation and sexual function**

In addition to the patients' age, general condition, and psychological state, sexual function following prostate surgery is also influenced by certain local factors, such as intraoperative blood loss and thermal injury. According to the data analysis, patients who get TURP do not experience any adverse effects on their sexual function. Additionally, a 12-year follow-up research showed that individuals who had enucleation saw a lasting improvement in their pre-operative erectile dysfunction [31].

TURP and enucleation did not exhibit a statistically significant difference in the recovery of sexual function following surgery, according to the most recent data. Furthermore, it was determined that the improvement of LUTS was positively correlated with sexual satisfaction. In patients who have undergone TURP, retrograde ejaculation is a common occurrence, with a global recognition of up to 50%. The detrimental psychological and physiological effects it has on patients have led to its potential as a cause of sexual dysfunction (32).

In this context, several scholars demonstrate that because enucleation involves the more thorough removal of glandular tissues than TURP, it may potentially have greater detrimental consequences on sexual functions. Nevertheless, the authors contend that the opposite is true for the following reasons [33]:

- By reducing the mechanical pressure of the hypertrophic gland on the erectile nerves, enucleation significantly enhances the hemodynamic parameters of erectile function and reduces the strain on the surgical capsule. In elderly men who have undergone surgery, this assists in the restoration of sexual function.
- Enucleation along the surgical capsule plane preserves the physiological structure of the prostatic fossa and intravesical sphincter while also more successfully maintaining erectile function. As a result, there is a decreased incidence of retrograde ejaculation following surgery.

Conclusion

Enucleation is considered as a prime example of the enhanced surgical technique, which is founded on a consistent principle, regardless of the surgical devices used, and is easily accessible due to the ease of access to the necessary equipment. Furthermore, enucleation procedures have the potential to more effectively eliminate the obstructing adenoma, thereby facilitating improved long-term clinical outcomes.

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