# Overview of The anatomical endoscopic enucleation of the prostate for patients with Benign prostatic hyperplasia

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## Abstract

Benign prostatic hyperplasia (BPH) is one of the most prevalent clinical complaints in older men and is thought to affect 10% of men in their 50s and approximately 90% of those over the age of 80. Due to its long-term course, BPH can develop various serious complications in results of lower urinary tract symptoms (LUTS) and sexual dysfunction. Despite a lifetime medical therapy being suggested as first-line management for LUTS/BPH, there is still a high discontinuation rate that is attributed to both drug side effects on sexual functions and patients' high expectations. Over the past three decades research has focused on the development of new surgical strategies to reduce morbidity and complications of conventional surgical procedures, such as transurethral resection of the prostate and open prostatectomy, but in most cases overlooking the impact on the patients ejaculatory function. The Endoscopic enucleation of the prostate (EEP) has been recognized as a viable treatment option for men with lower urinary tract symptoms. The aim of the current study was to review the surgical and anatomical consideration of endoscopic enucleating of the prostate in BPH management.

**Keywords:** Endoscopic Enucleating of Prostate; Prostatic Hyperplasia;

## Introduction

Lower urinary tract symptoms due to benign prostatic hyperplasia (BPH) are one of the most common health problems in men **(1)**. Transurethral surgery is the most common surgical method for BPH. The anatomical endoscopic enucleation of the prostate (AEEP) first performed as holmium laser enucleation of prostate **(2)**. HoLEP has been known to be a safe and effective transurethral surgical technique for BPH. In addition, HoLEP is associated with a high level of patient satisfaction after surgery and has fewer side effects than conventional transurethral resection of the prostate **(3)**.

Among transurethral surgery for benign prostatic hyperplasia (BPH), anatomical endoscopic enucleation of the prostate (AEEP) differs from conventional transurethral surgery as it adopts the same enucleation principle as open surgery **(4)**.

The first concept of anatomical enucleation by an endoscopic approach was described by Hiraoka in 1983 with the use of a monopolar system **(5)**. EEP Era Begin when Frauendorfer and Gilling in 1998 developed and introduced the pulsed Holmium-Laser and, subsequently to Holmium-Laser Enucleation of the Prostate (HoLEP) into clinical practice. It has Attract much attention from the urological world and has undergone popularity due to its achievement of maximal adenoma removal with significantly less morbidity. HoLEP remains the most well-studied procedure in AEEP and has demonstrated its superior outcome efficacy, durability and safety **(6)**.

Acronym EEP Endoscopic Enucleation of the Prostate is considered as one of the developments in endoscopic prostate surgery. It was brought to worldwide by effort of researchers and introduced to the European Association of Urology Guidelines in 2016 **(7)**. Nowadays, EEP continues to evolve rapidly and is not only limited to HoLEP. Various energy sources and a wide spectrum of operative techniques have been adopted by different surgeons with success **(8)**.

## I. Anatomical Considerations of AEEP:

- **Prostatic capsular plane `White Line`:**

The fundamental step in AEEP is initially finding a prostatic capsular plane. Anatomically, the structure commonly called the prostatic capsule corresponds to the outer stromal edge of the prostate parenchyma. In terms of macroscopic anatomy. The compressed fibrous layer is intermingled with periprostatic tissue. Anterolateral aspect of the prostatic capsule suggest a part of urethral sphincter as the anterior fibromuscular stroma merges with detrusor muscle proximally and the external urethral sphincter distally **(Fig. 1).** This involve that the surgeon must identify a accurate prostatic capsular plane, as the capsule consider an important landmark **(9).**

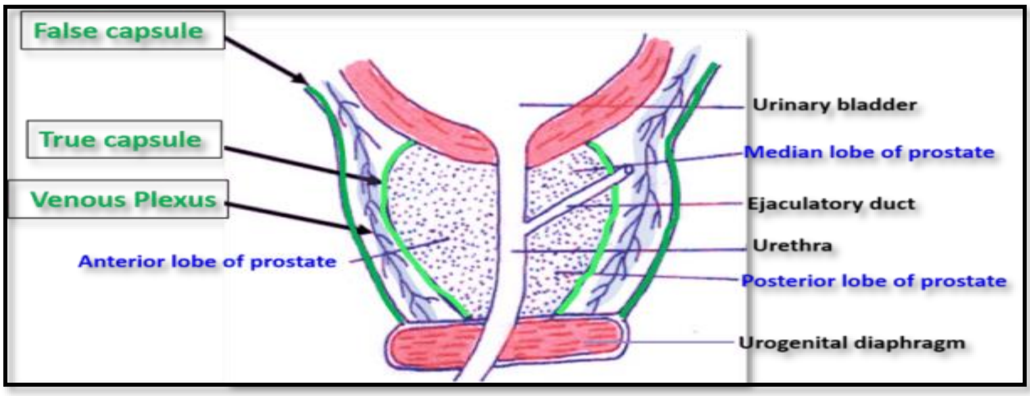


**Fig. (1): Prostatic capsule, venous plexus lies between the true & false capsules (9).**

- **The Trigonal and Urethral Musculature**

The trigone proper consists of two muscular layers which are superimposed over the detrusor muscle. The superficial layer is a direct continuation of the ureteric muscle. It is formed by the union of the longitudinal fibres in the roof and the floor of the intravesical ureter. The second trigonal layer is a direct continuation of Waldeyer's sheath forms a roughly triangular sheet of muscle that lies deep to the superficial layer **(Fig. 2)**. The apex of this triangular sheet lies at the internal meatus where most of the fibres are inserted **(10).**

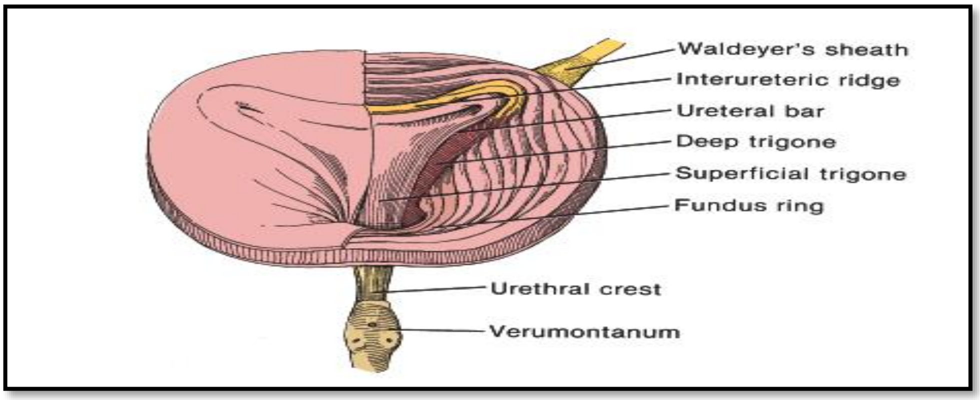


**Fig. (2): Trigonal muscular layers and arrangement**

- **Detrusor Vesicae**

Detrusor muscle consists of separate coarse bundles of smooth muscle over of the bladder body, the bundles change planes and directions, and they interlace so that a single fiber may continue through all three layers. The anterior longitudinal bundle joins the detrusor arch at the precervical arch **(Fig. 3)**. The middle layer between the outer and inner layers, the middle circular layer, has more or less circularly oriented fibers that form rings around the bladder wall from apex to base **(11).**

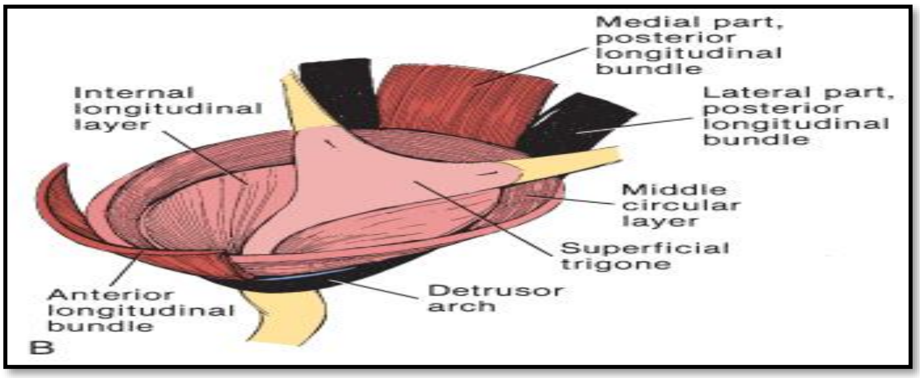


**Fig. (3) Coarse bundles of smooth muscle of detrusor arch**

- **Vesical Neck**

The vesical neck sphincteric system consists of bundles ofthe middle circular layer of the detrusor that run obliquely forward and down around the urethral orifice to join the deep layer of the anterior longitudinal bundles of the outer coat **(Fig. 4)**. The a relationship between combined smooth muscle and elastic fibers compress the soft mucosal lining and continuity with the preprostatic sphincter plays role in achieve and maintaining continence **(12)**.

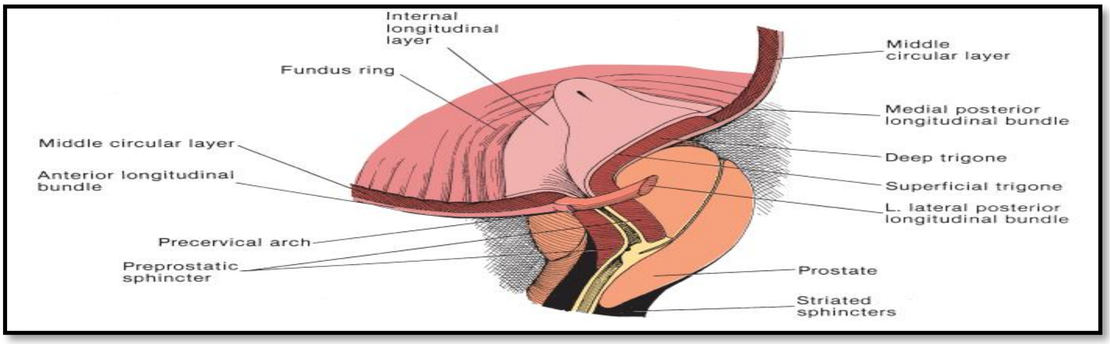


**Fig (4): Vesical Neck and perprostatic sphincter**

- **Preprostatic Sphincter**

The preprostatic sphincter is in continuity with the middle circular layer of the bladder that forms the fundus ring. The proximal portion surrounds the bladder neck and extends into the base of the prostate, where it becomes continuous with the smooth muscle of that organ. The fibers of the preprostatic sphincter are distinctly different morphologically and functionally from those of the adjacent detrusor **(Fig. 5)**. The function of this complex is to maintain continence at the vesical neck and to prevent retrograde seminal ejaculation **(12)**.

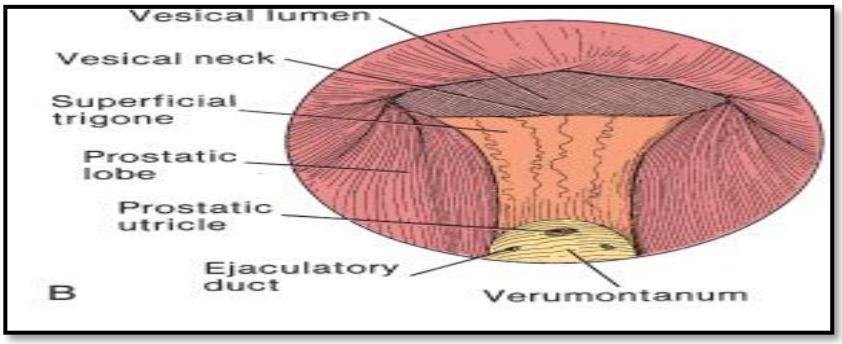


**Fig (5) superficial trigone is seen on the floor extending to the verumontanum which contains the prostatic utricle and the ejaculatory ducts**

- **Prostatic Urethra**

The urethra traversing the prostate is between 3 and 4 cm long, extending from the vesical neck to the membranous urethra. The prostatic urethra (prostatic segment of the prostatic urethra) runs through the distal half of the prostate, lying below the entrance of the ejaculatory ducts. It is about 2 cm long and is the portion surrounding and lying distal to the verumontanum. An elevated ridge along the dorsal wall of the prostatic urethra, the urethral crest, contains longitudinal smooth muscle fibers that are continuous proximally with the superficial trigone and distally with the smooth muscle of the ejaculatory ducts. The urethral prostatic sinuses are recesses beside the urethral crest on the floor on either side of the utricle. The orifices of the prostatic ducts that drain the three prostatic zones are distributed along the sinuses **(13)**.

- **Rhabdosphincter**

It's part of urethral sphincter complex, consisting of striated muscle fibers surrounds the membranous urethra from the apex of the prostate to the corpus spongiosum, in the shape of an inverted horseshoe and then continues proximally over the anterolateral surface of the prostate as the semi-lunar cap **(Fig. 6)**. The rhabdosphincter shows atrophy of its prostatic part, of which the fibers become indistinctly dispersed among the smooth muscles and glands of the prostate. The rhabdosphincter has a dual genitourinary function it's shown in arrangement of the muscle fibers of the prostatic rhabdosphincter, Contraction of cranial part of the rhabdosphincter would only produce side-to-side compression of the prostatic urethra, which result in antegrade propulsion of semen in the presence of a closed vesical orifice **(14)**.

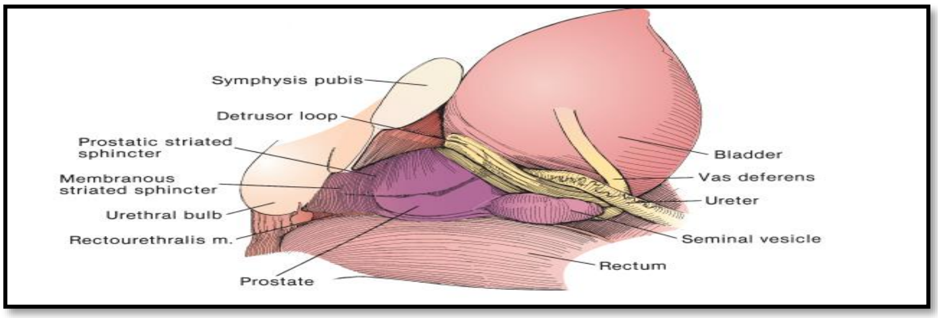


**Fig. (6) Diagram show rhabdosphincter RS**

## II. Surgical Considerations in AEEP:

The surgical technique of AEEP using holmium laser originally developed as a three-lobe technique **(15)**. Subsequently, modified surgical techniques have been developed by many surgeons, and the surgical technique has evolved significantly. The en bloc methods contributed to the diversification of AEEP surgical techniques.

In AEEP surgery, finding a correct prostatic capsular plane is the most basic step that must be performed initially. This is because the capsule itself is an important landmark for surgery. Anatomically, a structure commonly called the prostatic capsule corresponds to the outer stromal edge of the prostate parenchyma. In terms of macroscopic anatomy, a more accurate expression for this prostatic capsule would be 'pseudocapsule'. The prostatic capsule is a compressed fibromuscular layer with smooth muscles arranged transversely **(16,17)**. A whole-organ histological study of 23 prostate glands obtained from radical prostatectomy suggested that the anterolateral aspect of the prostatic capsule is a part of the urethral sphincter, especially in the anterior apex. Capsule shape has significant individual variation **(18)**.

Although somewhat different surgical methods have been proposed, it is generally accepted that the surgeon should find the initial capsular plane around the median lobe. The classic Gilling's 3-lobe technique involves finding the capsular plane by making longitudinal incisions from the bladder neck distally on both sides in the 5 and 7 o'clock directions **(19)**.

As a modified method, **Gong et al. (20)** started enucleation of the left lobe in the prostatic apex. The capsule is found by starting an incision along the border between the left lateral lobe and the urethra from the left side of the verumontanum.

Moreover, **Oh (21)**, and **Kim et al. (22)** revealed an initial small longitudinal incisions on both sides of the verumontanum to identify the prostatic capsule and later connected the two incision lines with new longitudinal incisions starting at the 5 and 7 o'clock positions of the bladder neck.

Compared with the method of finding the capsular plane by making a longitudinal incision from the bladder neck from the beginning, the method of initially finding the capsular plane with small incisions on both sides of the verumontanum has the some advantages as the correct capsular plane can be identified with relative ease with the latter method. In addition, the latter method is advantageous for the subsequent formation of mucosal wings in both lateral lobes, which is necessary for separation of the sphincter and the adenoma.

Some en bloc methods started by incising the urethral mucosa around the verumontanum to find the initial capsular plane **(23)**. However, other surgeons prefer to find the prostatic capsule initially at the 12 o'clock position of the prostatic apex. The Milan group set the starting point for en bloc enucleation at the anterior apex. The mucosal incision starts at the 11 o'clock and 1 o'clock positions of the prostatic apex located more proximal than the sphincter edge. After the initial incision, the prostatic capsule and adenoma in the apex are completely separated by deepening the incision. The incision is further extended in the 10 o'clock and 2 o'clock directions. Despite the variation in starting point, most urologists find prostatic capsules around the verumontanum and use it as a landmark for further surgical processes **(24)**.

In small prostates, the ejaculatory duct may be exposed due to perforation of the prostatic capsule during enucleation of the median lobe directly above the verumontanum if the incision over the capsule is deep. During enucleation of the lateral lobe, there are cases where the capsular planes in different directions do not match perfectly. In other words, the capsular plane made by downward enucleation from the 12 o'clock position to the 3 o'clock position may not join the capsular plane created by upward enucleation from the 6 o'clock position to the 3 o'clock position. It is often the case that the downward plane is deeper than the upward plane. In such cases, it is necessary to proceed with enucleation to the bladder neck by combining the two planes into one **(25)**.

A clinical study involving a full functional-length urethral preservation radical prostatectomy technique for prostate cancer showed that this striated muscle also extends into the prostatic apex **(26)**. This urethral sphincter complex is primarily located at the distal end of the prostatic apex. The striated sphincter may be symmetrical or asymmetrical according to individual variation. Therefore, it is very difficult to develop a uniform standard protocol for a sphincter-saving AEEP technique to prevent urinary incontinence **(27)**.

One of the most serious complication after prostate surgery for BPH is stress urinary incontinence. In general, the rate of urinary incontinence that persists up to 6 months after HoLEP is 5%–18% **(28,29)**.

Within 3 months after HoLEP surgery, 80% of patients recover from urinary incontinence **(30)**. The aetiology of stress urinary incontinence is multifactorial. Many clinical factors are involved, such as the patient's age, past history of neurological disease, shape of the prostate, size of the prostate, accompanying bladder dysfunction and the patient's general health status. There has been little progress in research on the anatomy and physiology of the urethral sphincter. Sphincter anatomy has drawn attention recently as the rate of radical prostatectomy for prostate cancer has increased as urinary incontinence is a major complication **(31)**.

Urinary incontinence after AEEP can be divided into urgency urinary incontinence due to detrusor overactivity and stress urinary incontinence due to sphincter weakness. Stress urinary incontinence, which persists six months onths or longer after surgery, is considered a minor issue since the amount of urinary incontinence is minimal in most cases. In this case, we can speculate that urinary incontinence is more likely to be caused by alterations in the urethral mucosa or submucosal tissue rather than direct sphincteric injury. In the female urethra, the urethral mucosa and vascular subepithelial tissue play very important roles in achieving urinary continence by maintaining the coaptation of the urethral lumen **(32)**.

On the other hand, during the AEEP procedure, mechanical dilatation of the urethra is caused by the endoscopic instrument. This results in a high possibility of transient urinary incontinence immediately after AEEP. In particular, the urethra is more likely to be passively dilated when a prostatic adenoma is larger. This is because the duration of endoscopic manipulation is prolonged and the range of motion of the endoscope during surgery is greater **(33)**.

## CONCLUSION:

Anatomical endoscopic enucleation of the prostate (AEEP) is known as an effective and safe surgical method.

During the AEEP procedure, an accurate understanding of the surgical anatomy of the capsular plane, bladder neck, apical sphincteric area and blood vessels is important.

The most significant advantage of AEEP is that it is based on the same surgical principles as open surgery. This means that the surgery is performed closer to the sphincter than in TUR-P. This comes with a drawback; however, in that AEEP is more likely to cause post-operative stress urinary incontinence than TUR-P.

However, during AEEP surgery, damage to the urethral mucosa or mucosal fibrosis may occur at the surgical site. Urinary incontinence frequently occurs because the urethral lumen is not completely closed.

**No Conflict of interest.**

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