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Bipolar enucleation of the prostate—step by step

Seung Hoon Ryang[1] | Tam Hoai Ly[2] | Ahn Vu Tran[2] | Seung-June Oh[1] | Sung Yong Cho[1]

[1]Department of Urology, Seoul National University Hospital, Seoul, Korea

[2]Department of Urology, Chợ Rẫy Hospital, Ho Chi Minh City, Vietnam

Correspondence
Sung Yong Cho, Department of Urology, Seoul National University Hospital, 101, Daehak-ro, Jongno-gu, Seoul, 03080, South Korea.
Email: kmoretry@daum.net

Abstract

Bipolar enucleation of prostate (BipolEP) is a useful method for treatment of benign prostatic hyperplasia (BPH). Compared with conventional transurethral resection, the enucleation technique has several advantages. However, since the cost of laser equipment used for enucleation is relatively high, enucleation using bipolar devices has been attempted by many previous surgeons. We consider bipolar enucleation is an effective and safe procedure, and we would like to share our experience of equipment settings and procedures through this article. We will introduce the equipment and settings of BipolEP and then present the actual step-by-step procedures and surgical tips. First, circular incisions are made on bladder neck and mucosa at the level of verumontanum. Then, enucleation is performed in the order of median and lateral lobes as in laser enucleation. Haemostasis should be done throughout the procedure. After enucleation and haemostasis, prostatic tissue is evacuated by morcellator. Currently, there are several types of electrode and morcellator systems. In our experience, BipolEP has a steep learning curve but it is safe and effective procedure for managing BPH. In particular, effective haemostasis is the greatest advantage of BipolEP when compared to traditional TUR or laser enucleation.

KEYWORDS

bipolar transurethral enucleation and resection of the prostate, endoscopic enucleation of prostate, enucleation, morcellation, prostatic hyperplasia, transurethral resection of prostate

1 | INTRODUCTION

Transurethral resection of the prostate (TURP) was initially published in the 1920s. Since then, TURP technique has been applied as the gold standard for the treatment of benign prostatic hyperplasia (BPH; Oelke et al., 2013; Xie et al., 2012). While modifications of techniques have made TURP performed by experienced surgeons generally safe and benefits of TURP have been amply documented, complications such as haemorrhage and transurethral resection (TUR) syndrome (Taylor & Jaffe, 2015) in traditional TURP have also been reported. With recent advances in instruments, several types of energy, including holmium, potassium-titanyl-phosphate (KTP) and thulium laser, have been increasingly applied for the management of BPH. Some studies have reported that laser surgery could be more efficient and safer procedures than TURP, irrespective of prostate size (Bach et al., 2011; Netsch et al., 2017; Roehrborn, 2008). Even with these advantages, prostate enucleation by laser has not been widely accepted for some reasons, including high cost and prolonged learning curve (Cornu, 2016; Lourenco et al., 2009). Hence, bipolar enucleation of prostate (BipolEP) as a combination equaliser of highly skilled TURP with good result of laser enucleation has appeared. BipolEP has been performed as an effective method for the management of BPH in some institutions. Case after case, the authors have modified our

techniques to facilitate BipolEP in patients with BPH. The authors also analysed difficulties in our procedures and provided solution for them. To the best of our knowledge, there has been no standardised technique for BipolEP described in any guideline. Thus, the authors in the present study would like to provide common basic principles of performing BipolEP.

In the present manuscript, the authors would describe our detailed surgical techniques and some comments about other surgeons' tips of BipolEP with practical recommendations based on available reports and personal experience.

2 | INTRODUCTION OF INSTRUMENTS

Bipolar enucleation of prostate is a transurethral procedure using energy source of bipolar electrosurgical unit. The procedure aims to enucleate the whole adenoma of the prostate. Enucleated prostatic tissues are removed with a morcellator. Thus, in clinical practice, bipolar enucleation of prostate includes both enucleation and morcellation procedures. Many researchers have evacuated enucleated tissues using 'Mushroom technique' without a morcellator (Abou-Taleb et al., 2017; Chiruvella et al., 2018; Gu et al., 2018; Hirasawa et al., 2012). However, safety and efficacy of morcellation after bipolar enucleation have also been demonstrated in previous studies when the surgeons kept in mind some surgical principles (Hirasawa et al., 2012). According to previous studies, 24 or 26 Fr resectoscopes are commonly used for the procedure. The range of energy settings used by previous researchers was 130 W to 280 W for cutting and 60 W to 110 W for coagulation (Abou-Taleb, 2017; Chiruvella et al., 2018; Gu et al., 2018; Hirasawa et al., 2012; Neill, 2006; Xu, 2018).

Currently, there are some popular electrode systems for bipolar enucleation that differ from each other by shape and operation mode. For example, there is PLASMA enucleation electrode (Olympus Medical Systems; Plasma System) which has a round spatula in front. It can gently peel of the adenoma without using energy if proper surgical plane is found (Figure 1a). Bipolar system of Olympus powered by ESG-400 high-frequency generator is usually introduced through the working channel of 24 Fr resectoscope. This system is 'quasi-bipolar', in which the current emitted from electrode of loop unintentionally flows through some urethral tissue and into the collecting electrode of the sheath of resectoscope. Several previous studies have suggested that it might cause post-operative membranous urethral stricture (Komura et al., 2014). However, further studies are needed to clarify whether leakage of current to the urethral tissue may make this happen or not.

Unlike the quasi-bipolar system, the HERRMANN bipolar vapo-enucleation electrode (Karl Storz) bipolar system is a true bipolar system, meaning that the output and return of the current are made in the same loop. The system is powered by an AUTOCON® III 400 high-frequency generator. The electrode is introduced through the working channel of 26 Fr resectoscope with a flat, cuneiform probe. The electrode can advance axially into surgical plane under direct visual guidance (Figure 1b). However, in our experience, outcomes of the two systems were similar (data not shown).

The morcellator is usually inserted into the bladder through the working channel. Three types of morcellators are most commonly used, each of which has different shape and movement of

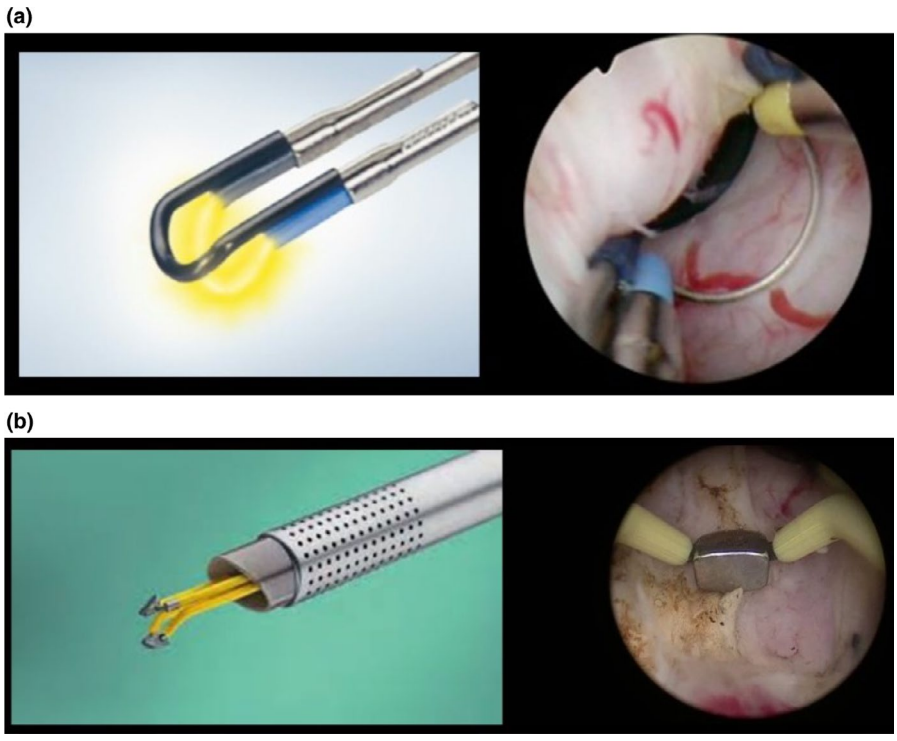

FIGURE 1 Different type of loop for bipolar enucleation of prostate (a) Plasma enucleation electrode (b) Herrmann bipolar vapo-enucleation electrode. (a) https://www.olympus-europa.com/medical/en/Products-and-Solutions/Products/Product/PLASMA-SYSTEM.html. (b) https://www.karlstorz.com/cps/rde/xbcr/karlstorz_assets/ASSETS/3528837.pdf

blades. DrillCut (Karl Storz) morcellator has a toothed-blade that shows oscillating movement like clock chest (https://www.karlstorz.com/cps/rde/xbcr/karlstorz_assets/ASSETS/3528837.pdf). Piranha (Richard Wolf Inc.; https://www.richard-wolf.com/en/disciplines/urology/piranha/) has a rotating toothed-blade. VersaCut (Versapulse; Lumenis Inc.) has a nontoothed blade with reciprocating piston movement (https://lumenis.com/solutions/surgical/holmium-products/versacut-tissue-morcellator; Ibrahim et al., 2018).

Sodium solution 0.9% is used throughout the procedure for irrigation. The height of the irrigating bag is about 30 cm above the operating bed during enucleation and at 80–100 cm during morcellation for distension of the bladder at physiological intravesical pressures (Scoffone & Cracco, 2015). Detailed settings for bipolar enucleation of prostate at our institution are shown in Table 1 and Figure 2.

2.1 | Step-by-step procedures

Under general or spinal anaesthesia, patients are placed in a lithotomy position. When performing prostate enucleation, resectoscope needs a wider range of motion than performing prostate resection (Kuo et al., 2003). Therefore, thighs should be abducted to ensure enough space for the resectoscope to operate. After sterile draping, lubricating jelly is injected to the urethra and urethral dilation up to 24–28 Fr is gently performed. Then, 24 or 26 Fr continuous flow resectoscope and working element are inserted into bladder. If urethral dilation up to 28Fr is unavailable, perineal approach through a urethrostomy or transvesical simple prostatectomy can be considered depending on the urethral diameter and prostate size (Oelke et al., 2013). The authors in the present study would consider enucleation procedures with 24 Fr resectoscope and bipolar system of Olympus in the first place in this situation regarding the difference between 28Fr and 24Fr.

TABLE 1 Bipolar enucleation of prostate equipment in Seoul National University Hospital

Karl Storz Inc., Tuttlingen, Germany
AUTOCON® III 400 Bipolar electrosurgical unit
HERRMANN bipolar vapo-enucleation electrode
26-F continuous flow resectoscope sheath (27040SL/XA)
26-F nephroscope with offset lens (27292 AMA)
Adapter for connecting to resectoscope sheath (27040 LB)
Olympus, Tokyo, Japan
PLASMA enucleation electrode
26-F continuous flow resectoscope sheath (A22040)
Lumenis Inc., Santa Clara, CA
VersaCut tissue morcellator (Versapulse)
Stryker Co., San Jose, CA
Video tower and endoscopic camera

2.2 | Step 1: Cystoscopic inspection

To prevent damage to surrounding organs such as external sphincter, operator must be aware of the three-dimensional circular structure of prostate during enucleation. Verumontanum and bilateral ureteral orifices are important landmarks for prostate orientation (Tan & Gilling, 2002). However, it is difficult to identify them after starting the procedure. For this reason, cystoscopic inspection should be conducted before starting the procedure. The bladder should be inspected to make sure whether there are no foreign bodies, stones or tumours (Nayak et al., 2018). Enough distance from bladder neck to ureteral orifices should be guaranteed when there is high intraprostatic protrusion. The authors normally try to incise the bladder mucosa at the posterior part of the intraprostatic protrusion at the bladder neck level in the first place.

2.3 | Step 2: Circumferential incision of mucosa at bladder neck and prostate apex

Although the resection plan varies depending on surgeon preference, it should always be undertaken in a methodical approach. While a variety of resection schemas are acceptable, some surgeons recommend resection of the median lobe, if present, as the first step (Geavlete et al., 2013; Welliver et al., 2017). However, the present authors suggest that we may start BipolEP with a bladder neck incision as it removes the more proximal portion of the prostate and allows for free flow of irrigant in case of later bleeding (Kim et al., 2013). Full-mucosal thickness transverse incision is made around the bladder neck just proximal to the base of prostate (Figure 3a). By doing this, we can prevent possible damages to detrusor muscle or ureteral orifices by excessive undermining the fibromuscular tissue of bladder neck. This technique is especially helpful when there is huge intraprostatic protrusion.

After setting surgical margin through the bladder neck incision as described above, mucosal incisions are made to distinguish external sphincter and apex of prostate and to find the starting point of the enucleation plane (Figure 3b). Incisions start at 5 and 7 o'clock direction, just lateral to the verumontanum. The incision runs along the margin between the prostate and the sphincter muscle. It should be close to the prostate nodule to prevent sphincter damage by traction force of the scope. We fix the scope with the left hands at the verumontanum level and rotate the scope with the right hands laterally for pushing the prostate nodules to find the enucleation planes.

Anterior margin of prostate apex can be found easier after incisions are made along posterior and lateral margins of prostate apex. In the anterior margin of the prostate apex, incision is made in the same way as posterior and lateral margins (Figure 3c). It is relatively easy to make mucosal incisions on the anterior side of prostate apex using laser fibre (Figure 3d), but using round-shaped bipolar loops is challenging for beginners. However, using a bipolar loop designed specifically for enucleation, mucosal incisions can be performed in the same manner as with laser fibre (Figure 3e). However, the

FIGURE 2 Bipolar enucleation of prostate equipment in Seoul National University Hospital. (a) Bipolar electrosurgical unit, monitor and pedal (b) Bipolar vapo-enucleation electrode, cystoscope, continuous flow resectoscope sheath, nephroscope with offset lens, adapter for connecting to resectoscope sheath and camera head (c) Two sets of 3L irrigation bags

incision does not normally look like a sharp line, but like a band especially when the surgeons use a half-moon type loop or a square-type loop. 'Band'-shaped incision using vaporisation mode can be made when authors cannot make sharp and clear incision using a loop type electrode at 9–12 o'clock and 12–3 o'clock to facilitate meeting of both ends of lateral enucleation plane and anterior lobe plane.

Through this early circular incision on prostate nodule, distal surgical margin can be identified during procedure and tearing of external sphincter induced by traction during enucleation can be prevented. After setting the surgical margin by making incisions on bladder neck and prostate apex, incisions are made for enucleation.

2.4 | Step 3: Initial longitudinal incision and median lobe enucleation

For the case of bi-lobular hypertrophy, longitudinal incision is usually made at the sulcus between median and lateral lobes. The incision runs from the bladder neck to just proximal to the verumontanum. In tri-lobular hypertrophy which has a prominent median lobe, longitudinal incisions along the lateral margin of the median lobe are made (Figure 4a). These incisions start at the sulci between median and lateral lobes at 5 o'clock position, approximately 1–2 loops next to the verumontanum where the amount of tissue is scarce and independent from the size of the adenoma. If surgeons want to perform en-bloc technique of the three lobes, enucleation of the median lobe is not necessary because it can be removed together with enucleated lateral lobe.

To remove the median lobe, transverse incision is made just proximal to the verumontanum level and deepened to capsular fibre depth (Figure 4b). If the transverse incision can be made relatively high from the verumontanum to avoid injury to ejaculatory ducts, risk of epididymitis and retrograde ejaculation. However, the evidence about this is not clear. The median lobe is then pushed up from the verumontanum to the bladder neck using beak of the resectoscope with loop dissection in a retrograde fashion (Figure 4c,d). The surgical plane may not be clear near the bladder neck because of annular fibrotic tissue. Some large median lobes can be extended deeply over bladder neck and even near ureteral orifices. Thus, the operator must be careful not to damage ureteral orifices or undermine the fibrous tissue of the bladder neck (Shah et al., 2007). As mentioned earlier, the present authors perform early mucosal incision at bladder neck in the first place, which may help reduce undermining of the fibrous tissue.

2.5 | Step 4: Lateral lobe enucleation

To start enucleation of lateral lobes, proper surgical plain should be identified in order to prevent external sphincter injury and reduce the risk of bleeding (Chiruvella et al., 2018; Xu et al., 2018). Through above-mentioned incisions on apex of prostate, separation between

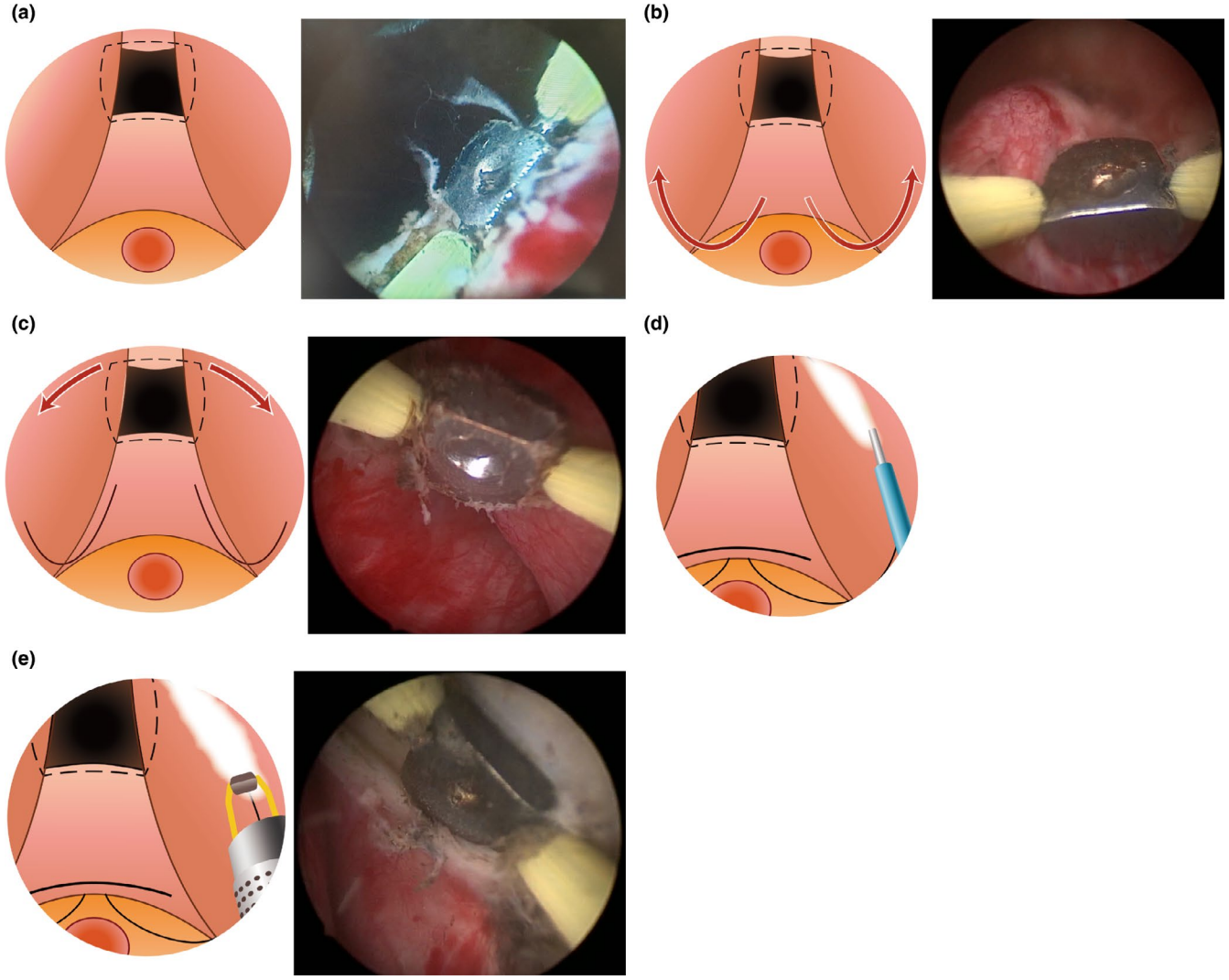

FIGURE 3 Step-by-step procedure (a) Circumferential incision of mucosa at bladder neck. (b) Circumferential incision of posterior side of prostate apex at 5 and 7 o'clock at the level of verumontanum. (c) Circumferential incision of anterior side of prostate apex from 12 o'clock. (d) Early mucosal anterior incision on prostate nodule using laser fibre. (e) Early mucosal anterior incision on prostate nodule using HERRMANN bipolar vapo-enucleation electrode

surgical capsule and lateral lobe of adenoma is performed laterally and upwardly (Figure 4e). If the direction of dissection is not oriented upward, mucosal crack can be extended to the bulbous urethra. Surgical planes are widened upward to 10 o' clock (right lobe) and 2 o'clock (left lobe) after finding the correct plane. The 'swing' movement of electrode and endoscopic pushing movement according to enucleation plane is important to make clear enucleation plane while surgeons imagine circular margin of prostate adenoma to prevent capsular perforation. Back-and-forth movement of enucleation electrodes may facilitate identification of enucleation plane.

2.6 | Step 5: longitudinal incision at 12 o'clock position

A longitudinal incision at 12 o'clock position is suggested by most surgeons (Geavlete et al., 2013). The incision starts from bladder neck and ends at the just proximal to the level of verumontanum. From longitudinal incision at 12 o'clock position, operator should find surgical plane of lateral lobes for downward enucleation. This is very challenging for beginners because the anterior lobe is very thin and mainly composed of fibromuscular tissue (El-Hakim & Elhilali, 2002). Therefore, excessive anterior resection can cause sphincter injury which can lead to urinary incontinence or massive bleeding. Previously made full-mucosal thickness longitudinal incision on 12 o'clock direction can be good landmarks for downward dissection. If proper plane of lateral lobe's upper side is found, downward enucleation is performed in retrograde fashion from 11'o clock and 1'o clock positions (Figure 4f).

2.7 | Step 6: Finishing enucleation

Two oblique mucosal incisions from 10 to 2 o'clock between the prostate nodule and the bladder neck can be made for finishing

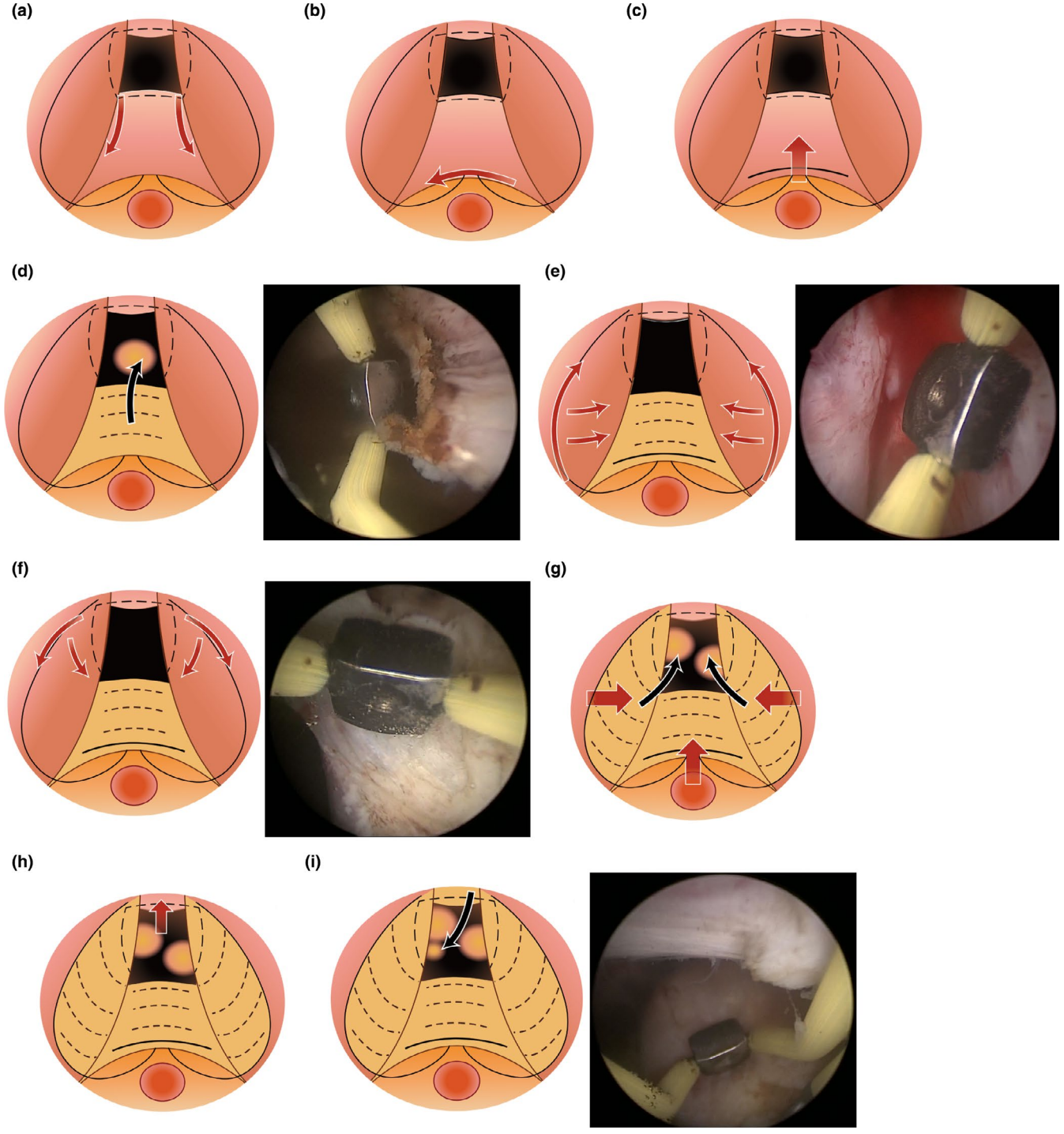

FIGURE 4 (a) Longitudinal incision for median lobe enucleation, (b) transverse incision for median lobe enucleation, (c) enucleation of median lobe; (d) Pushing up the enucleated median lobe into bladder; (e) Enucleation of post-erolateral side of lateral lobes; (f) Anterior longitudinal incision and enucleation of anterior side of lateral lobes; (g) Pushing up the lateral prostatic nodules into bladder; (h) Enucleation of anterior lobe; (i) Pushing down the anterior lobe into bladder

enucleation after we make substantial amount of enucleation especially in the case of En-bloc enucleation procedures (Scoffone & Cracco, 2015). However, enucleation of lateral lobes can be finished by conjoining planes of upward and downward enucleation if surgeons choose bilobar or trilobar enucleation techniques. Operator should widen surgical planes while anticipating the conjoining point of incisions from upward and downward. If surgical planes meet properly, lateral lobes are fully separated from surgical capsules. They can be pushed up to the bladder easily (Figure 4g).

In a large prostate, upward and downward planes might not meet each other even after appropriate enucleation due to satellite nodule. In such cases, dissection using energy device should be

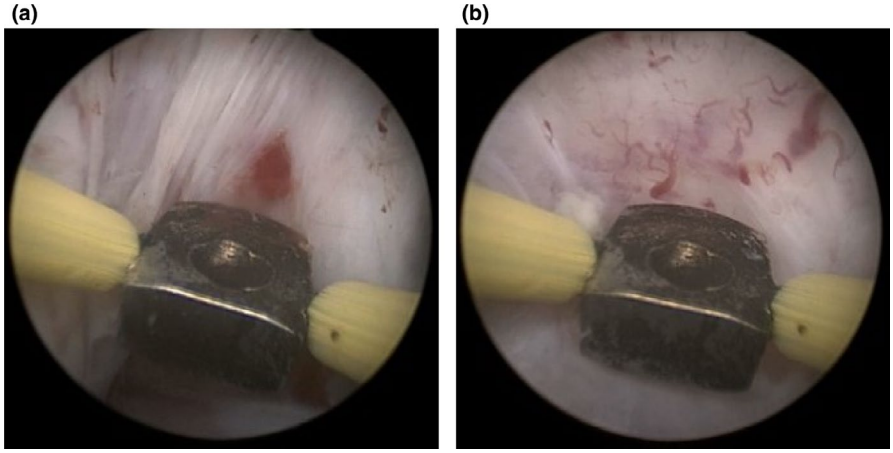

FIGURE 5 Types of intrasurgical bleeding (a) End vessel that perforates surgical capsule; (b) Creeping vessel that runs beneath the surgical capsule

performed to merge these two surgical planes. To maintain simple and single surgical plane, operator should prioritise the main adenoma nodules. The present authors recommend that satellite nodules would be managed using bipolar vaporisation. Resection of adenoma nodule during early enucleation procedure is not recommended because resected tissue chips may affect the visual field during procedure.

2.8 | Step 7: Anterior lobe enucleation

Anterior lobe is not so common during enucleation of lateral lobes. Anterior part is basically thin. Thus, caution is required during enucleation. Some small nodules can be encountered between 11 and 1 o'clock at the level of the verumontanum in some cases. We normally hesitate to remove them because we think it would not mainly affect the surgical outcomes and it may make any sphincter injury. However, if the anterior lobe is large and hard to remove, it needs to be removed separately likewise the median lobe (Abou-Taleb et al., 2017). A transverse incision is made at 12 o'clock position proximal to verumontanum level, and the anterior lobe is pushed up with beak of resectoscope and loop in retrograde fashion (Figure 4h,i). Anterior lobe vaporisation may be a viable option if the loop electrode is not enough to make a sharp incision at the proximal end of prostate.

2.9 | Step 8: Haemostasis and bubble formation

Haemostasis is one of the most powerful advantages of BipolEP compared to other energy devices for enucleation. The safety profile of BipolEP technology is excellent in terms of bleeding control. Compared to monopolar TURP, BipolEP may have a lower risk for perioperative haemorrhage (Cornu et al., 2015; Yang et al., 2016). The use of coagulation mode is recommended to maintain haemostasis through the procedure as an incremental process. If the bleeding is not controlled during the procedure, the small volume of bleeding can become overwhelming to the surgeon. Clear visual field is essential for successful enucleation by identifying a proper surgical plane. Haemostasis is also important after enucleation because morcellation can be safely performed only when the visual field is clear (Gilling et al., 1998). There are mainly two types of bleeding that will be noted during the procedure. One is bleeding of the end vessel that perforates the surgical capsule (Figure 5a). The other is bleeding of the creeping vessel that runs beneath the capsule (Figure 5b). In our experience, bipolar energy is more effective than laser energy source to perform haemostasis quickly. Haematoma attached to the enucleation bed or electrode can be easily removed by vaporisation.

Bubble formation is one of the important disadvantages of BipolEP compared to other energy devices. Surgeons may feel difficulty to perform enucleation procedures with the cutting mode

TABLE 2 Surgical outcomes of bipolar enucleation of prostate

Authors (Country, *n*)	Mean age (years)	Operative time (min)	Prostate volume (ml)	Qmax Pre-operative (ml/s)	Qmax Post-operative (ml/s)	IPSS Pre-operative	IPSS Post-operative
R. Giulianelli (Italy, 129)	64 ± 7	97.02 ± 25.9	94.8 ± 14.99	8.73 ± 3.2	22.3 ± 4.74	21.72 ± 5.15	4.78 ± 2.36
M. Chiruvella (India, 103)	64 ± 7	54	98	9 ± 3	23 ± 7	24 ± 3	8 ± 2
W. El-Shaer (Egypt, 245)	65.5 ± 6	76.9 ± 27.9	97.1 ± 36.7	7.1 ± 3.2	18.4 ± 4.2	25 ± 6	7.9 ± 2.4
C. Liu (China, 52)	67.9 ± 6.4	43.1 ± 4.0	72.4 ± 10.2	9.18 ± 2.88	27.7 ± 5.01	22.1 ± 3.2	2.23 ± 0.7
R. Autorino (Italy, 35)	59 ± 5.9	4	51.6 ± 3.9	7.1 ± 2	3.9	24.2 ± 4	20.8

when an electric current heat the normal saline and gas bubbles are inevitably generated as the saline evaporates. The easiest way of continuing the enucleation procedure is to move to another space. For example, when we cannot proceed with the procedure any more after we cut the mucosa at 5 o'clock position just next to the verumontanum, we can move to anterior part at 12 o'clock and proceed with the procedure.

2.10 | Step 9: Morcellation

After proper haemostasis, enucleated prostatic tissues are removed through morcellation. Morcellation is a relatively simple, safe and effective method to remove prostatic tissue. However, it can cause bladder mucosal injury with considerable probability (Montorsi et al., 2004; Shah et al., 2007). Therefore, operator should proceed with it carefully and the risk of bladder injury should not be overlooked. Before starting morcellation, bladder must be distended enough to prevent mucosal injury (Seki et al., 2003).

When the prostatic tissue is caught in the blade of morcellator, rotating the handle before aspiration to see movability of the resected nodule may help prevent bladder mucosal injury. If the enucleated tissue is caught properly, operator can use 'Swivel technique' to rotate the handle and the resected nodule without resistance. Some small round-shaped hard nodules may not be removed by morcellation. They should be removed by resection or using long forceps. If there are considerable amount of resected chips, we can consider the use of Ellik evacuator to remove all of them.

2.11 | Patients' data in previous investigations

As shown in Table 2, patients who underwent bipolar enucleation showed comparable outcomes regardless of differences in surgical techniques and the devices (Abou-Taleb et al., 2017; Autorino et al., 2009; Chiruvella et al., 2018; Giulianelli et al., 2019; Xu et al., 2018). Further investigations would be mandatory to show detailed differences according to different surgical techniques.

3 | CONCLUSION

In this paper, we presented some modified techniques for performing bipolar enucleation of prostate including (a) early circular mucosal incision at the bladder neck and prostate apex, (b) 'band-shaped' incision on the lateral prostate nodule with blunt bipolar electrodes and (c) some technical points using bipolar electrodes. This procedure can be helpful to get clear visual field, shortened enucleation and coagulation time, and reduced complication rates. It has efficiency for large size adenoma as well. Additionally, our method can be an approach easily used by beginner surgeons, hence facilitating their learning curve. However, as every technique has its potential limitation, further assessment and long-term evaluation are definitely needed in the future.

ORCID

Seung Hoon Ryang https://orcid.org/0000-0002-0974-2073
Ahn Vu Tran https://orcid.org/0000-0002-8744-9438
Seung-June Oh https://orcid.org/0000-0002-0322-3539
Sung Yong Cho https://orcid.org/0000-0001-9271-6951

REFERENCES

Abou-Taleb, A., El-Shaer, W., Kandeel, W., Gharib, T., & Elshaer, A. (2017). Bipolar plasmakinetic enucleoresection of the prostate: our experience with 245 patients for 3 years of follow-up. *Journal of Endourology*, *31*(3), 300–306. https://doi.org/10.1089/end.2016.0746

Autorino, R., Damiano, R., Di Lorenzo, G., Quarto, G., Perdonà, S., D'Armiento, M., & De Sio, M. (2009). Four-year outcome of a prospective randomised trial comparing bipolar plasmakinetic and monopolar transurethral resection of the prostate. *European Urology*, *55*(4), 922–929. https://doi.org/10.1016/j.eururo.2009.01.028. Epub 2009 Jan 24

Bach, T., Netsch, C., Pohlmann, L., Herrmann, T. R., & Gross, A. J. (2011). Thulium:YAG vapoenucleation in large volume prostates. *Journal of Urology*, *186*(6), 2323–2327. https://doi.org/10.1016/j.juro.2011.07.073

Chiruvella, M., Enganti, B., Bendigeri, M. T., Ghouse, S. M., Ragoori, D., & Reddy, P. (2018). Transurethral enucleation with bipolar energy (TUEB): AINU technique and short-term outcomes. *Urology*, *122*, 147–151. https://doi.org/10.1016/j.urology.2018.09.001

Cornu, J.-N. (2016). Bipolar, monopolar, photovaporization of the prostate, or holmium laser enucleation of the prostate. *Urologic Clinics of North America*, *43*(3), 377–384. https://doi.org/10.1016/j.ucl.2016.04.006

Cornu, J.-N., Ahyai, S., Bachmann, A., Rosette, J. D. L., Gilling, P., Gratzke, C., … Madersbacher, S. (2015). A systematic review and meta-analysis of functional outcomes and complications following transurethral procedures for lower urinary tract symptoms resulting from benign prostatic obstruction: An update. *European Urology*, *67*(6), 1066–1096. https://doi.org/10.1016/j.eururo.2014.06.017

Gilling, P. J., Kennett, K., Das, A. K., Thompson, D., & Fraundorfer, M. R. (1998). Holmium laser enucleation of the prostate (HoLEP) combined with transurethral tissue morcellation: An update on the early clinical experience. *Journal of Endourology*, *12*(5), 457–459. https://doi.org/10.1089/end.1998.12.457.

El-Hakim, A., & Elhilali, M. (2002). Holmium laser enucleation of the prostate can be taught: The first learning experience. *BJU International*, *90*(9), 863–869. https://doi.org/10.1046/j.1464-410x.2002.03071.x

Geavlete, B., Stanescu, F., Iacoboaie, C., & Geavlete, P. (2013). Bipolar plasma enucleation of the prostate vs open prostatectomy in large benign prostatic hyperplasia cases - a medium term, prospective, randomized comparison. *BJU International*, *111*(5), 793–803. https://doi.org/10.1111/j.1464-410x.2012.11730.x

Giulianelli, R., Gentile, B. C., Mirabile, G., Tema, G., Albanesi, L., Tariciotti, P., Lombardo, R. (2019). Bipolar plasma enucleation of the prostate vs. open prostatectomy in large benign prostatic hyperplasia: a single centre 3-year comparison. *Prostate Cancer and Prostatic Disease*, *22*(1), 110–116. doi: https://doi.org/10.1038/s41391-018-0080-7.

Gu, M., Chen, Y.-B., Liu, C., Wan, X., Cai, Z.-K., Chen, Q., & Wang, Z. (2018). Comparison of holmium laser enucleation and plasmakinetic resection of prostate: a randomized trial with 72-month follow-up. *Journal of Endourology*, *32*(2), 139–143. https://doi.org/10.1089/end.2017.0700

Hirasawa, Y., Ide, H., Yasumizu, Y., Hoshino, K., Ito, Y., & Masuda, T. (2012). Comparison of transurethral enucleation with bipolar and

transurethral resection in saline for managing benign prostatic hyperplasia. *BJU International*, *110*(11c), 11381.x. https://doi.org/10.1111/j.1464-410x.2012

Ibrahim, A., Elhilali, M. M., Elkoushy, M. A., Andonian, S., & Carrier, S. (2018). DrillCutTM vs. VersaCutTM prostate tissue morcellation devices after holmium laser enucleation: A prospective, randomized controlled trial. *Canadian Urological Association Journal*, *13*(8), https://doi.org/10.5489/cuaj.5626

Kim, M., Lee, H.-E., & Oh, S.-J. (2013). Technical aspects of holmium laser enucleation of the prostate for benign prostatic hyperplasia. *Korean Journal of Urology*, *54*(9), 570. https://doi.org/10.4111/kju.2013.54.9.570

Komura, K., Inamoto, T., Takai, T., Uchimoto, T., Saito, K., Tanda, N., … Azuma, H. (2014). Incidence of urethral stricture after bipolar transurethral resection of the prostate using TURis: Results from a randomised trial. *BJU International*, *115*(4), 644–652. https://doi.org/10.1111/bju.12831

Kuo, R. L., Paterson, R. F., Kim, S. C., Siqueira, T. M. Jr, Elhilali, M. M., & Lingeman, J. E. (2003). Holmium laser enucleation of the prostate (HoLEP): A technical update. *World J Surg Oncol*, *1*, 6. https://doi.org/10.1186/1477-7819-1-6

Lourenco, T., Armstrong, N., N'Dow, J., Nabi, G., Deverill, M., Pickard, R. … Grant, A. (2009). Systematic review and economic modelling of effectiveness and cost utility of surgical treatments for men with benign prostatic enlargement. *Clinical Governance: An International Journal*, *14*(2), 169–515. https://doi.org/10.1108/cgij.2009.24814bab.003

Montorsi, F., Naspro, R., Salonia, A., Suardi, N., Briganti, A., Zanoni, M., … Rigatti, P. (2004). Holmium laser enucleation versus transurethral resection of the prostate: Results from a 2-center, prospective, randomized trial in patients with obstructive benign prostatic hyperplasia. *Journal of Urology*, *172*(5), 1926–1929. https://doi.org/10.1097/01.ju.0000140501.68841.a1

Neill, M. G., Gilling, P. J., Kennett, K. M., Frampton, C. M., Westenberg, A. M., Fraundorfer, M. R., & Wilson, L. C. (2006). Randomized trial comparing holmium laser enucleation of prostate with plasmakinetic enucleation of prostate for treatment of benign prostatic hyperplasia. *Urology*, *68*(5), 1020–1024. https://doi.org/10.1016/j.urology.2006.06.021

Netsch, C., Becker, B., Tiburtius, C., Moritz, C., Becci, A. V., Herrmann, T. R. W., & Gross, A. J. (2017). A prospective, randomized trial comparing thulium vapoenucleation with holmium laser enucleation of the prostate for the treatment of symptomatic benign prostatic obstruction: Perioperative safety and efficacy, *35*(12), 1913–1921. https://link.springer.com/article/10.1007/s00345-017-2071-z

Oelke, M., Bachmann, A., Descazeaud, A., Emberton, M., Gravas, S., Michel, M. C., … Rosette, J. J. D. L. (2013). EAU guidelines on the treatment and follow-up of non-neurogenic male lower urinary tract symptoms including benign prostatic obstruction. *European Urology*, *64*(1), 118–140. https://doi.org/10.1016/j.eururo.2013.03.004

Roehrborn, C. (2008). Morbidity, mortality and early outcome of transurethral resection of the prostate: A prospective multicenter evaluation of 10,654 patients. *Yearbook of Urology*, *2008*, 93–95. https://doi.org/10.1016/s0084-4071(08)79167-x

Scoffone, C. M., & Cracco, C. M. (2015). The en-bloc no-touch holmium laser enucleation of the prostate (HoLEP) technique. *World Journal of Urology*, *34*(8), 1175–1181. https://doi.org/10.1007/s00345-015-1741-y

Seki, N., Mochida, O., Kinukawa, N., Sagiyama, K., & Naito, S. (2003). Holmium laser enucleation for prostatic adenoma: analysis of learning curve over the course of 70 consecutive cases. *Journal of Urology*, *170*(5), 1847–1850. https://doi.org/10.1097/01.ju.0000092035.16351.9d

Shah, H. N., Mahajan, A. P., Hegde, S. S., & Bansal, M. B. (2007). Peri-operative complications of holmium laser enucleation of the prostate: Experience in the first 280 patients, and a review of literature. *BJU International*, *100*(1), 94–101. https://doi.org/10.1111/j.1464-410x.2007.06867.x

Plasma System. PLASMA system: urology: olympus medical systems. Retrieved from https://www.olympus-europa.com/medical/en/Products-and-Solutions/Products/Product/PLASMA-SYSTEM.html

Tan, A. H., & Gilling, P. J. (2002). Holmium laser prostatectomy: Current techniques. *Urology*, *60*(1), 152–156. https://doi.org/10.1016/s0090-4295(02)01648-5

Nayak, P., Mallikarjuna, C., Ghouse, S., Reddy, P., Ragoori, D., Bendigeri, M., & Reddy, S. (2018). Transurethral enucleation with bipolar energy for surgical management of benign prostatic hyperplasia: Our initial experience. *Indian Journal of Urology*, *34*(3), 219. https://doi.org/10.4103/iju.iju_71_16.

Taylor, B. L., & Jaffe, W. I. (2015). Electrosurgical transurethral resection of the prostate and transurethral incision of the prostate (monopolar techniques). *The Canadian Journal of Urology*, *22*(Suppl 1), 24–29.

Welliver, C., Helo, S., & Mcvary, K. T. (2017). Technique considerations and complication management in transurethral resection of the prostate and photoselective vaporization of the prostate. *Translational Andrology and Urology*, *6*(4), 695–703. https://doi.org/10.21037/tau.2017.07.30

Xie, C.-Y., Zhu, G.-B., Wang, X.-H., & Liu, X.-B. (2012). Five-year follow-up results of a randomized controlled trial comparing bipolar plasmakinetic and monopolar transurethral resection of the prostate. *Yonsei Medical Journal*, *53*(4), 734. https://doi.org/10.3349/ymj.2012.53.4.734

Xu, P., Xu, A., Chen, B., Zheng, S., Xu, Y., Li, H., … Liu, C. (2018). Bipolar transurethral enucleation and resection of the prostate: Whether it is ready to supersede TURP? *Asian Journal of Urology*, *5*(1), 48–54. https://doi.org/10.1016/j.ajur.2017.12.001

Yang, E. J., Li, H., Sun, X. B., Huang, L., Wang, L., Gong, X. X., & Yang, Y. (2016). Bipolar versus monopolar transurethral resection of the prostate for benign prostatic hyperplasia: Safe in patients with high surgical risk. *Scientific Reports*, *6*, 21494. https://doi.org/10.1038/srep21494

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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