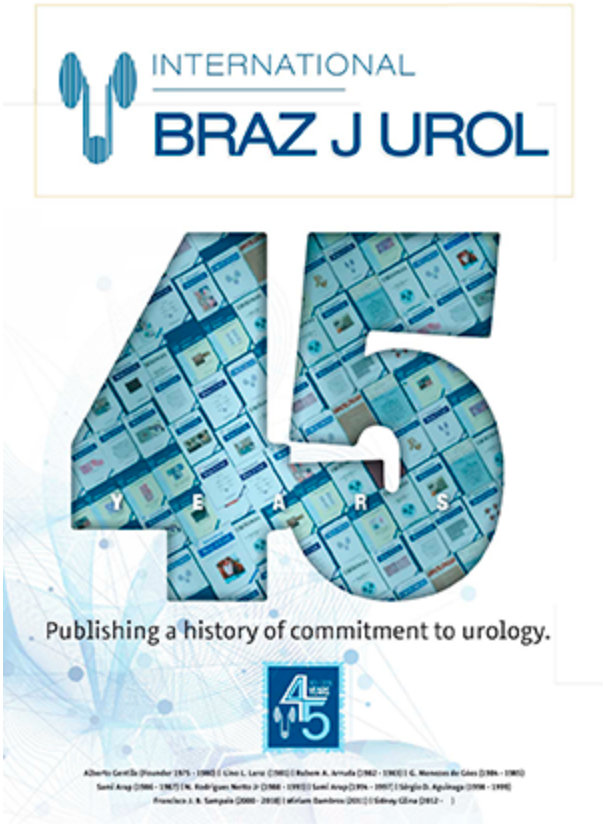


# ANATOMIC STUDY OF VEROMONTANUM DURING ENDOSCOPIC SURGERIES IN PATIENTS WITH BENIGN PROSTATIC HYPERPLASIA

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# ANATOMIC STUDY OF VEROMONTANUM DURING ENDOSCOPIC SURGERIES IN PATIENTS WITH BENIGN PROSTATIC HYPERPLASIA

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**Running head: Veromontanum endoscopic anatomy.**

**Key-words**: Benign prostatic hyperplasia; Seminal colliculus; Lower urinary tract symptoms; Ejaculatory disorder; 5-alpha reductase inhibitors.

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# ANATOMIC STUDY OF VEROMONTANUM DURING ENDOSCOPIC SURGERIES IN PATIENTS WITH BENIGN PROSTATIC HYPERPLASIA

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## ABSTRACT

Introduction and objective: To evaluate changes in verumontanum anatomy in patients with benign prostatic hyperplasia (BPH) using 5-alpha reductase inhibitors (5-ARIs) and to propose an anatomical classification of the verumontanum.

Methods: We studied 86 patients with BPH and 7 patients without the disease (age under 40 years-old who underwent kidney or ureteral lithotripsy). Of the patients with BPH, 34 (mean age=67.26) had 5-alpha reductase inhibitor use and 52 (mean age=62.69) did not use the drug. During the surgeries, photographs of the seminal colliculus were taken and later, with the aid of software (Image J), the length (longitudinal diameter) and width (transverse diameter) of the verumontanum were measured in all patients. During the procedure, we evaluated the different types of verumontanum. For statistical analysis, the R-Project software was used.

Results: In the group of patients with BPH who were taking the medication, the mean measures of length and width of the verumontanum were 4.69 mm and 2.94 mm respectively. In the group of patients with BPH who did not use the drug, the mean diameters were 4.54mm and 3.20 mm respectively. In the control group, the average length and width were 5.63 mm and 4.11 mm respectively. There was an increase in longitudinal and transverse measurements of the control group with an increase in body mass index (BMI) ($p = 0.0001$ and $p = 0.035$ respectively). In addition, there was a reduction in transverse diameter in the group of HPB using 5-ARI with increased prostate volume ($p = 0.010$). We found five different verumontanum types: “volcano” (51.61%), “lighthouse” (24.73%), “whale tail” (12.90%), “hood” (5.38%) and “castle door” (5.38%), which we propose as an anatomical classification.

Conclusion: Veromontanum has smaller measurements in patients with BPH who used and those who did not use the medication as the prostate enlarged. In the control group, there was an increase in verumontanum diameter with an increase in BMI. The volcano type of verumontanum was the most frequent regardless of groups and BMI.

**ABREVIATIONS**

1- BPH – Benign prostatic hyperplasia

2- 5-ARIs – 5-alpha-reductase inhibitors

3- BMI – Body mass index

4- DBC – Delayed bladder catheter

5- TUR – Transurethral resection

6- $R^2$ – Odds ratio

7- PSA – Prostate-specific antigen

8- IPSS – International prostate symptom score

9- LUTS – Lower urinary tract symptom

10- AUR – Acute urinary retention

## INTRODUCTION

The verumontanum (seminal colliculus) is a bulge distal to the urethral crest that presents the prostatic utricle (remnant of the Muller ducts) and the two ejaculatory ducts (1). The verumontanum originates from the endoderm of the bladder part of the urogenital sinus, and has great anatomical and functional importance due to the presence of ejaculatory ducts, fundamental structures for semen elimination. Thus, this structure plays an important role in reproduction (2). It can be affected by problems such as cysts or polyps, which lead to symptoms of emptying, dysuria, hematuria, infertility, hemospermia, prostatitis and urinary tract infection (3).

Although there are anatomical classifications of the prostate (McNeal and Randall) (4,5) and classification of the prostate utricle (6), so far no classification of the seminal colliculus has been created.

Benign prostatic hyperplasia (BPH) is one of the most common diseases in men, with progressive incidence according to age. BPH leads to lower urinary tract symptoms due to intra-bladder obstruction (7). Among the medications used to treat BPH, 5-alpha-reductase inhibitors are prominent because they are able to alter the natural history of the disease by decreasing prostate volume (8). There are two types of 5-alpha-reductase inhibitors: finasteride and dutasteride. Finasteride acts by inhibiting type 2

enzyme while dutasteride inhibits type 1 and 2. However, this class of drugs has side effects such as ejaculatory disorders and reduced semen volume (8-10).

Previous studies analyzing the anatomy of the verumontanum in BPH and in patients with normal prostates are scarce in the literature. We hypothesized that the verumontanum anatomy could be altered in patients with BPH by the use of 5-alpha-reductase inhibitors, which could justify side effects such as ejaculatory disorders, which is unheard of in the literature. We also propose a new classification for endoscopic verumontanum anatomy

The aim of this paper is to evaluate changes in verumontanum anatomy in patients with benign prostatic hyperplasia (BPH) using 5-alpha-reductase inhibitors (5-ARIs) and to create an anatomic classification for the verumontanum.

## MATERIALS AND METHODS

The experimental protocol described here was approved by the committee for ethical human experimentation of our university. This study was carried out in accordance with the ethical standards of the hospital's institutional committee on human experimentation (opinion number 3.233.220).

We studied 86 patients with BPH (age 41 to 85 years, mean = 64.5 years) and 7 patients without BPH, who formed the control group (age 29 to 38 years, mean = 32.71 years), between March 2018 and October 2019. Of the patients with BPH, 34 used 5-alpha-reductase inhibitors (Group 1) and 52 did not use this class of drugs (Group 2). The average age of group 1 was 67 years and the average age of group 2 was 62 years. All the patients in the study were evaluated by the same professional, who applied the same questionnaire. Data were collected such as age, height, weight, body mass index (BMI), prostate weight, alpha-blocker use, 5-alpha-reductase inhibitor use, presence of systemic arterial hypertension and diabetes mellitus, and delayed bladder catheter (DBC) use.

Inclusion criteria: Patients with BPH who underwent transurethral resection of the prostate or bladder and patients younger than 40 years without BPH who underwent an endoscopic procedure to treat urolithiasis composed the control group (because the literature shows that at this age

the incidence of BPH increases) (7). Exclusion criteria: All patients with any other prostate pathology (prostate cancer, prostatitis, prostate cyst, etc.), patients with BPH who used finasteride or dutasteride for less than 6 months (because the literature shows that at this moment the drugs start to have the best effect) (11), as well as patients undergoing any minimally invasive surgical treatment of the prostate.

Verumontanum measurement of patients with BPH was standardized and performed by the same surgeon in all patients. During transurethral resection (TUR) surgery, photographs of the verumontanum were taken and the images were analyzed using Image J version 1.46r, with its plug-in (http://rsb.info.nih.gov/ij/). The longitudinal and transverse diameters of the seminal colliculus were measured using the distance between the two ends of the resectoscopic loop, which was determined prior to surgery individually as a measurement parameter. The distance of the resection loop and the optics was standardized. In the case of patients in the control group, the measurement was made using the diameter of a ureteral catheter (previously known measure) as a parameter for verumontanum diameter measurement (Figure 1). All verumontanums were initially photographed without the resection loop and without the ureteral catheter in the visual field so that they could be evaluated to standardize a classification of their anatomy.

After completing the verumontanum measurements, comparisons were made between the following groups: patients with BPH who used 5-alpha-reductase inhibitors (group 1), patients with BPH who did not use 5-alpha-reductase inhibitors (group 2), and patients under 40 years of age undergoing the endoscopic procedure to treat urolithiasis (group 3, control). In addition, comparisons of verumontanum size with age, BMI and prostate size were performed. After the analysis of all verumontanums, we proposed a new classification for the organ's morphology.

Statistical analysis was performed using the R-Project software, version 3.5.3. The Kruskal-Wallis test and Dunn's post-test were used to verify if there was a statistically significant difference between the means of the variables. The Mann-Whitney mean comparison test was used to evaluate the prostate size variables present in groups 1 and 2. Simple linear correlations were calculated to compare verumontanum measurements with variables in the three groups. We considered p-values $<0.05$ as statistically significant.

## RESULTS

All variables studied are presented in Table 1. The mean, standard deviation and median of BMI, prostate volume and verumontanum measurements are shown in Table 2.

In the control group, there was an increase in longitudinal ($r^2$=1.521; p=0.0001) and transverse ($r^2$=0.819; p=0.0354) measurements of the verumontanum with rising body mass index (BMI), with statistical significance. However, in the comparison according to age, verumontanum diameters decreased (longitudinal diameter ($r^2$ = -0.771; p = 0.169) and transverse diameter ($r^2$ = -0.576; p = 0.114) ) as age increased (Figure 2).

In BPH patients who used 5-alpha-reductase inhibitors (group 1), when comparison of the verumontanum measurements and BMI revealed an increase in longitudinal diameter ($r^2$ = 0.059; p = 0.3529) and a slight increase in transverse diameter ($r^2$ = 0.004; p = 0.9052) with an increase in BMI. In this group there was a reduction in longitudinal ($r^2$ = -0.022; p = 0.3833) and transverse ($r^2$ = -0.016; p = 0.3079) diameters with increasing age. In the comparson with prostate volume, there was a reduction in longitudinal ($r^2$ = -0.010; p = 0.3850) and transverse ($r^2$ = -0.015; p = 0.0108) diameters as the prostate volume increased, but only the transverse diameter was statistically significant (Figure 3).

In the group of patients with BPH who do not use 5-alpha reductase inhibitors (group 2), there was a reduction in longitudinal diameter ($r^2$ = -0.010; p = 0.8664) and an increase in transverse diameter ($r^2$ = 0.019; p = 0.6291) as the BMI increased; reduction in transverse diameter ($r^2$ = -0.0112; p = 0.4440) and increase in longitudinal diameter ($r^2$ = 0.023; p = 0.3223) with increasing age; and decreases of longitudinal ($r^2$ = -0.005; p = 0.7060) and transverse ($r^2$ = -0.005; p = 0.532) diameters with increasing prostate volume (Figure 3).

The graphs show that the verumontanum did not increase with age in the three groups. It can also be noted that the verumontanum did not increase with increased prostate volume, suggesting that in patients with BPH there is no associated growth of the verumontanum together with the prostate.

During the anatomical analysis of the verumontanum, we observed five different morphological types, whose nomenclature we created according to their appearance (Figure 4): “Volcano” colliculus is a short colliculus with the utricle at its upper extremity; “Lighthouse” colliculus is longer colliculus with the anterior utricle at its upper extremity; “Whale Tail” colliculus is a short, flattened organ with an elongated urethral crest; “Hood” colliculus is the most elongated colliculus of all, tapered and continuous with the urethral crest; and “Castle Door” colliculus is a broad, short colliculus with enlarged prostate utricle. Group 1 presented frequency of verumontanum types as follows: 12 (35.29%) patients with “Volcano” colliculus; 8 (23.53%) with “Whale tail”; 7

(20.59%) with “Lighthouse”; 4 (11.76%) with “Hood”; and 3 (8.82%) with “Castle Door” type. In the analysis of group 2, the frequency pattern was: 32 (61.54%) patients with “Volcano” type colliculus; 14 (26.92%) with “Lighthouse”; 3 (5.77%) with “Whale Tail”; 2 (3.85%) with “Castle Door”; and 1 (1.92%) with “Hood” type.

In the control group, the “Volcano” colliculus was present in 4 (57.14%) patients, “Lighthouse” in 2 (28.57%) patients and “Whale Tail” in 1 (14.29%) patient.

There was no statistical difference in the comparison between the three groups (p = 0,0908).

Of the patients who were using delayed bladder catheters, 10 (50%) had “Volcano” colliculus, 4 (20%) had “Whale Tail”, 3 (15%) had “Lighthouse”, 2 (10%) had “Hood”, and 1 (5%) had “Castle Door”.

Among obese (BMI ≥ 30 kg/m$^2$), overweight (BMI 25 - 29.9 kg/m$^2$) and normal patients (BMI ≤ 24.9 kg/m$^2$), the “Volcano” verumontanum was the most frequent in all of them, presenting frequencies of 7 (46.66%), 29 (52.72%) and 12 (52.17%) respectively, with statistical significance (p = 0.022).

## DISCUSSION

The 5-alpha-reductase inhibitors are known to act by inducing apoptosis of prostate epithelial cells (12), leading to a reduction in prostate size of about 18-28% and a decrease in serum PSA levels of about 50% after six to twelve months of treatment (8,11). In addition, 5-alpha-reductase inhibitors improve IPSS by 15-30% and urinary maximal flow by 1.5-2.0 ml/s in patients with LUTS (9,10). 5-alpha-reductase inhibitors reduce the long-term risk (> one year) of acute urinary retention (AUR) or the need for surgery (13). In addition, finasteride can decrease bleeding during transurethral prostate resection (TURP) surgery, probably due to its effects on prostate vascularization (14).

However, there is no information in the literature on whether this class of drugs alters the verumontanum volume. In the present study, the mean verumontanum measurements were higher in the control group compared to the group without the drug, where the transverse diameter was larger than in the group that used the medicine. This suggests that 5-alpha-reductase inhibitors also decrease the verumontanum size.

In addition to decreased libido and erectile dysfunction, it is now known that the use of 5-alpha-reductase inhibitors can cause ejaculatory disorders and reduced semen volume (8-10,15). The cause of these

ejaculatory disorders is not known, but we can speculate that changes in verumontanum size could be involved.

In our sample, in patients of group 1 and group 2, we observed a decrease in verumontanum measurements together with an increase in prostate volume, but only the decrease in verumontanum transversal measurement in the BPH group who used the drug was statistically significant.

BMI and metabolic syndrome are important in the incidence and prognosis of prostate diseases (16). There are no reports in the literature of alteration of verumontanum morphology in patients with BPH using 5-alpha-reductase inhibitors. In our study, we observed in patients who used 5-alpha-reductase inhibitors an increase in both diameters (mainly in the longitudinal diameter) with increase of BMI. In the group who did not use 5-alpha reductase inhibitors, the longitudinal diameter of the verumontanum decreased and the transverse diameter increased as the BMI increased. And in the control group, verumontanum diameters increased as BMI increased, with statistical significance.

During prostate TURP surgery, there is concern about verumontanum injury. Thus, Malalasekera and collaborators (17) performed a 3D study of the pathway of the ejaculatory ducts through the prostate to try to define a way to minimize the chance of ejaculatory duct injury during trans-urethral resection of the prostate, and he suggested preserving the prostate tissue

located 7.5 mm on either side of the verumontanum from the midline and 10 mm proximal to the verumontanum. Thus, knowledge of the anatomy of the verumontanum is again important to define resection limits in the surgical treatment of BPH (17).

Another condition to be discussed would be obstructive azoospermia. This disease leads to infertility due to obstruction of the male reproductive tract, which can occur anywhere (rete testis, efferent ducts, epididymis, vas deferens and ejaculatory duct) (18). One of the tests used to diagnose this condition is seminal vasography/vesiculography, which consists of catheterization of the ejaculatory ducts through the verumontanum and contrast injection (19,20). When the obstruction is located in the ejaculatory ducts, the ideal treatment is transurethral resection of the ejaculatory duct, accessed through the verumontanum (20). Thus, better knowledge of the anatomy of the verumontanum, as well as its classification, may help in endoscopic treatment of obstructive azoospermia. These facts reinforce the importance of knowledge of seminal colliculus anatomy.

The average diameter of verumontanum in group 3 was higher than in group 2, which was higher than in group 1, suggesting that 5-alpha-reductase inhibitors shrink the prostate as well as the verumontanum. Patients using 5-alpha-reductase inhibitors showed increased longitudinal diameter of the verumontanum with increasing BMI. In the group who did not use 5-alpha reductase inhibitors, there was a reduction in longitudinal

diameter and an increase in transverse diameter of the verumontanum as the BMI increased. The verumontanum was smaller in patients with BPH who used and those who did not use 5-alpha-reductase inhibitors as the prostate enlarged, suggesting that BPH does not increase the size of the verumontanum. In the control group, verumontanum diameters increased with increasing BMI, suggesting that obesity may be associated with increased verumontanum size. In all groups the measures of the verumontanum decreased with advancing age, except for group 2, which presented an increase in longitudinal diameter.

A finding of great interest during this study is that all patients could be grouped into one of the five categories of our verumontanum morphological classification. From what has been shown, we believe this classification represents anatomic reality and will be useful in future studies involving the verumontanum. We propose to classify the verumontanum into five different anatomical types ("Volcano", "Lighthouse", "Whale Tail", "Hood" and "Castle Door"). We observed that the "Volcano" colliculus was the most frequent (51.61% of all patients in the study), followed by the "Lighthouse Tower" and "Whale Tail" types, with the "Castle Door" and "Hood" being less prevalent. However, we did not observe any difference between the groups, suggesting that the type of colliculus is not altered by BPH, the use of 5-alpha-reductase inhibitors or the use of delayed bladder catheters.

The main limitations of the present study are: 1) presence of a small sample of patients; and 2) impossibility of measuring the third diameter of the verumontanum and consequently calculating its volume, because the image analyzed by endoscopy is obtained in two dimensions.

## CONCLUSION

The veromontanum measurements were smaller in patients with BPH who used and those who did not use the medicine as the prostate enlarged. In the control group, there was an increase in verumontanum diameters with an increase in BMI. We observed the presence of five morphological types of verumontanum in our sample ("Volcano", "Lighthouse", "Whale Tail", "Hood" and "Castle Door"), and the "Volcano" type was most frequent regardless of groups or BMI, suggesting that the use of 5-alpha-reductase inhibitors and obesity do not influence verumontanum morphology. Creating a new anatomical classification is always interesting. In addition, we believe this classification may help in endoscopic prostate surgery as well as future studies.

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## TABLES

Table 1 – All data and variables of all patients.

| Data and variables of patients with BPH | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Pt.** | **Age** | **LDV** | **TDV** | **Verum. Type** | **Prostate Size** | **5 ARI** | **OBES./BMI (kg/m²)** | **SAH** | **DM** | **DBC** |
| **1** | 55 | 2.75mm | 2.20mm | WT | 60g | Yes | Yes / 31.37 | No | No | No |
| **2** | 66 | 3.19mm | 3.3mm | V | 75g | Yes | No / 24.91 | No | No | Yes |
| **3** | 52 | 2.81mm | 3.39mm | WT | 54g | Yes | No / 27.3 | Yes | Yes | No |
| **4** | 72 | 3.71mm | 3.5mm | CD | 55g | Yes | No / 24.0 | No | No | Yes |
| **5** | 68 | 7.11mm | 2.2 mm | H | 46g | Yes | Yes / 38.4 | Yes | Yes | No |
| **6** | 64 | 6.6mm | 3.12mm | WT | 47g | Yes | No / 23.8 | Yes | Yes | Yes |
| **7** | 66 | 2.91mm | 2.26mm | V | 54g | Yes | No / 29.72 | No | No | Yes |
| **8** | 68 | 5.18mm | 3.23mm | H | 63g | Yes | Yes / 34.15 | Yes | No | Yes |
| **9** | 63 | 2.88mm | 2.04mm | CD | 65g | Yes | No / 22.59 | Yes | Yes | No |
| **10** | 58 | 4.56mm | 3.88mm | CD | 40g | Yes | No / 26.81 | Yes | No | No |
| **11** | 79 | 6.31mm | 4.2mm | V | 57g | Yes | No / 29.29 | Yes | No | No |
| **12** | 68 | 3.92mm | 4.0mm | V | 50g | No | No / 22.94 | No | No | No |
| **13** | 77 | 4.92mm | 3.0 mm | V | 140g | No | No / 26.9 | Yes | No | No |
| **14** | 72 | 8.31mm | 2.51mm | L | 40g | No | No / 20.06 | No | No | No |
| **15** | 66 | 4.37mm | 4.40mm | WT | 32g | Yes | No / 23.99 | No | No | No |
| **16** | 68 | 6.91mm | 3.24mm | H | 63g | Yes | No / 25.0 | Yes | No | Yes |
| **17** | 56 | 6.17mm | 3.95mm | L | 65g | Yes | No / 29.4 | Yes | No | No |
| **18** | 78 | 5.36mm | 2.11mm | WT | 66g | Yes | No / 23.6 | Yes | No | Yes |
| **19** | 63 | 4.51mm | 2.90mm | V | 40g | No | No / 25.0 | No | No | Yes |
| **20** | 68 | 5.29mm | 2.43mm | V | 51g | No | No / 25.9 | No | No | Yes |
| **21** | 60 | 5.33mm | 3.75mm | V | 41g | No | No / 22.7 | No | No | Yes |
| **22** | 52 | 7.28mm | 2.32mm | L | 70g | Yes | No / 25.0 | Yes | No | Yes |
| **23** | 68 | 7.29mm | 3.15mm | WT | 53g | Yes | No / 17.5 | Yes | No | Yes |
| **24** | 69 | 3.79mm | 2.75mm | V | 40g | No | Yes / 34.11 | Yes | Yes | No |
| **25** | 68 | 4.70mm | 4.17mm | V | 66g | No | No / 24.9 | No | No | Yes |
| **26** | 60 | 3.31mm | 3.07mm | V | 31g | No | No / 28.5 | Yes | No | No |
| **27** | 67 | 4.5mm | 3.06mm | V | 69g | No | No / 23.14 | No | No | Yes |
| **28** | 62 | 4.15mm | 3.81mm | V | 67g | Yes | No / 22.9 | Yes | Yes | No |
| **29** | 78 | 3.57mm | 1.24mm | H | 100g | Yes | No / 25.8 | Yes | No | No |
| **30** | 62 | 2.17mm | 2.4mm | V | 84g | Yes | No / 19.0 | Yes | Yes | No |
| **31** | 65 | 4.03mm | 1.7mm | L | 67g | Yes | No / 24.9 | No | No | Yes |
| **32** | 64 | 6.31mm | 4.14mm | L | 20g | No | No / 27.0 | No | No | No |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **33** | 72 | 5.87mm | 3.14mm | L | 52g | No | No / 28.6 | No | Yes | No |
| **34** | 67 | 2.24mm | 2.35mm | V | 33g | No | Yes / 31.0 | No | No | No |
| **35** | 72 | 5.91mm | 4.97mm | CD | 44g | No | Yes / 45.6 | Yes | No | No |
| **36** | 74 | 2.6mm | 2.4mm | WT | 30g | No | No / 23.0 | Yes | Yes | No |
| **37** | 81 | 3.19mm | 2.46mm | WT | 86g | Yes | No / 23.0 | Yes | No | No |
| **38** | 71 | 4.59mm | 1.96m | L | 59g | Yes | Yes / 32.0 | Yes | No | No |
| **39** | 74 | 5.59mm | 2.62mm | L | 48g | No | No / 28.0 | Yes | No | No |
| **40** | 59 | 4.77m | 3.19mm | V | 47g | Yes | No / 22.8 | No | No | No |
| **41** | 70 | 10mm | 6.61mm | V | 33g | No | No / 24.4 | Yes | No | No |
| **42** | 68 | 4.74mm | 3.75mm | V | 41g | Yes | No / 26.0 | No | No | No |
| **43** | 71 | 4.81mm | 2.99mm | V | 37g | Yes | No / 26.0 | No | No | Yes |
| **44** | 79 | 5.34mm | 2.77mm | L | 55g | Yes | No / 24.0 | No | Yes | No |
| **45** | 60 | 5.65mm | 3.92mm | V | 20g | Yes | Yes / 34.6 | Yes | No | No |
| **46** | 70 | 2.57mm | 2.51mm | WT | 42g | Yes | No / 21.5 | Yes | No | Yes |
| **47** | 58 | 7.93mm | 6.82mm | V | 20g | No | No / 24.9 | Yes | No | No |
| **48** | 82 | 4.93mm | 3.25mm | L | 40g | No | No / 24.9 | Yes | No | No |
| **49** | 60 | 4.49mm | 3.94mm | V | 63g | No | Yes / 31.4 | Yes | Yes | No |
| **50** | 77 | 3.59mm | 2.16mm | V | 36g | Yes | No / 28.0 | Yes | Yes | Yes |
| **51** | 44 | 3.1mm | 2.85mm | CD | 25g | No | No / 25.53 | No | No | No |
| **52** | 69 | 4.47 mm | 2.48mm | L | 56g | Yes | No / 27.68 | Yes | No | Yes |
| **53** | 70 | 4.92 mm | 2.30mm | L | 25g | No | No / 27.15 | Yes | No | No |
| **54** | 80 | 3.85mm | 2.13mm | V | 158g | Yes | No / 22.03 | Yes | No | No |
| **55** | 48 | 3.06mm | 2.67mm | V | 27g | No | No / 28.3 | Yes | No | No |
| **56** | 74 | 4.32 mm | 3.29mm | V | 24g | No | No / 26.98 | Yes | No | No |
| **57** | 57 | 4.58mm | 3.15mm | V | 35g | No | No / 26.49 | No | No | No |
| **58** | 56 | 4.42mm | 1.59mm | L | 35g | No | Yes / 32.11 | Yes | No | No |
| **59** | 70 | 4.22mm | 2.37mm | L | 51g | No | Yes / 32.0 | Yes | No | No |
| **60** | 46 | 2.22mm | 2.35mm | V | 29g | No | No / 23.87 | Yes | No | No |
| **61** | 49 | 4.92mm | 4.53mm | V | 27g | No | No / 27.76 | No | No | No |
| **62** | 41 | 4.49 mm | 3.23mm | V | 30g | No | No / 20.76 | No | No | No |
| **63** | 58 | 2.45mm | 2.66mm | V | 19g | No | No / 26.34 | No | No | No |
| **64** | 56 | 2.36mm | 5.09mm | V | 35g | No | No / 22.34 | No | No | No |
| **65** | 83 | 4.25mm | 3.13mm | V | 75g | No | No / 23.62 | No | No | Yes |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **66** | 76 | 8.0mm | 1.76mm | H | 30g | No | No / 24.7 | Yes | No | No |
| **67** | 61 | 3.80mm | 1.48mm | L | 30g | No | No / 22.34 | No | No | No |
| **68** | 63 | 5.34mm | 4.21mm | V | 31g | No | No / 27.71 | No | No | No |
| **69** | 50 | 4.94mm | 3.36mm | V | 28g | No | No / 29.58 | Yes | Yes | No |
| **70** | 42 | 3.17mm | 3.84mm | V | 30g | No | Yes / 34.33 | Yes | Yes | No |
| **71** | 52 | 3.65 mm | 2.56mm | V | 50g | No | No / 25.30 | Yes | No | No |
| **72** | 68 | 3.03 mm | 3.06mm | V | 65g | No | Yes / 31.37 | Yes | No | No |
| **73** | 72 | 2.22mm | 1.74mm | V | 42g | No | No / 27.16 | Yes | Yes | No |
| **74** | 49 | 4.03 mm | 2.54mm | L | 38g | No | No / 29.41 | No | No | No |
| **75** | 47 | 4.37 mm | 4.42mm | WT | 39g | No | No / 28.32 | Yes | No | No |
| **76** | 77 | 2.68mm | 2.64mm | V | 24g | No | No / 22.72 | No | No | No |
| **77** | 85 | 4.45mm | 4.33mm | V | 40g | Yes | No / 26.36 | No | No | No |
| **78** | 44 | 4.28 mm | 2.25mm | L | 27g | No | No / 27.68 | No | No | No |
| **79** | 61 | 2.42mm | 2.08mm | V | 75g | No | No / 24.77 | Yes | Yes | No |
| **80** | 51 | 8.08mm | 3.73mm | L | 75g | Yes | No / 24.38 | No | No | No |
| **81** | 76 | 3.75mm | 2.65mm | V | 54g | No | Yes / 31.57 | Yes | Yes | No |
| **82** | 68 | 4.38mm | 3.31mm | WT | 38g | No | No / 22.86 | No | No | No |
| **83** | 53 | 11.26mm | 5.6mm | L | 30g | No | No / 29.2 | No | No | No |
| **84** | 46 | 3.87mm | 2.87mm | L | 30g | No | No / 25.0 | Yes | No | No |
| **85** | 66 | 2.85mm | 1.64mm | L | 35g | No | No / 29.32 | Yes | Yes | No |
| **86** | 72 | 4.41mm | 3.46mm | V | 40g | No | No / 24.0 | Yes | Yes | No |

**Data and variables of patients without BPH (control group)**

| **Pt.** | **Age** | **LDV** | **TDV** | **Verum. Type** | **OBES./BMI (kg/m²)** | **SAH** | **DM** | **DBC** |
|---|---|---|---|---|---|---|---|---|
| **1** | 29 | 16.6mm | 10 mm | L | Yes / 34.0 | No | No | No |
| **2** | 37 | 3.14mm | 2.0mm | V | No / 25.9 | No | No | No |
| **3** | 38 | 2.77mm | 2.12mm | V | No / 25.39 | No | No | No |
| **4** | 34 | 2.79mm | 1.74mm | V | No /25.9 | No | No | No |
| **5** | 29 | 4.58mm | 2.81mm | WT | No / 25.6 | No | No | No |
| **6** | 30 | 5.28mm | 7.65mm | V | No / 26.06 | No | No | No |
| **7** | 32 | 4.26mm | 2.46mm | L | No / 26.77 | No | No | No |

Legend: Pt = Patient. LDV = Longitudinal diameter of the verumontanum. TDV = Transverse diameter of the verumontanum.. 5 ARI = 5-alpha-reductase inhibitor. OBES./BMI = Obesity / Body Mass Index. SAH = systemic arterial hypertension. DM =

Diabetes Mellitus. DBC = delayed bladder catheter. mm = millimeter. g = gram. V = volcano. WT = Whale Tail. L = Lighthouse. H = Hood. CD = Castle Door.
Note: Prostate volume was not included in the control group because in this age group there is no routine investigation of benign prostatic hyperplasia.
Source: Author database.

Table 2– Clinical characteristics of the studied groups.

| **Variables** | **Control** (n=7) **μ ± ∂ ; m** | **BPH+without 5ARIs** (n=52) **μ ± ∂ ; m** | **BPH+5ARIs** (n=34) **μ ± ∂ ; m** | ***P value*** |
|---|---|---|---|---|
| **Age (years)** | 32.71 ± 3.73; 32.00 | 62.69 ± 11.12; 65.00 | 67.26 ± 8.94; 68.00 | <0.0001 (1) |
| **Body mass index (kg/m²)** | 27.36 ± 3.72; 25.90 | 27.11 ± 4.19; 26.90 | 26.11 ± 4.38; 25.00 | 0.4203 (1) |
| **Prostate size (g)** | - | 40.85 ± 19.80; 35.00 | 59.85 ± 23.94; 56.50 | <0.0001 (2) |
| **Longitudinal diameter of the verumontanum (mm)** | 5.63 ± 4.93; 4.26 | 4.54 ± 1.86; 4.38 | 4.69 ± 1.56; 4.52 | 0.6990 (1) |
| **Transversal diameter of the verumontanum (mm)** | 4.11 ± 3.31; 2.46 | 3.20 ± 1.15; 3.03 | 2.94 ± 0.83; 3.06 | 0.6261 (1) |

Legend: BPH = Benign prostatic hyperplasia. 5ARIs = 5 alpha reductase inhibitors
Data were expressed as mean (μ) ± standard deviation (∂); median (m).
(1) Nonparametric differences were tested by Kruskal-Wallis and Dunn's posttest, p <0.05. (2) Nonparametric differences were tested by Mann-Whitney, p <0.05.

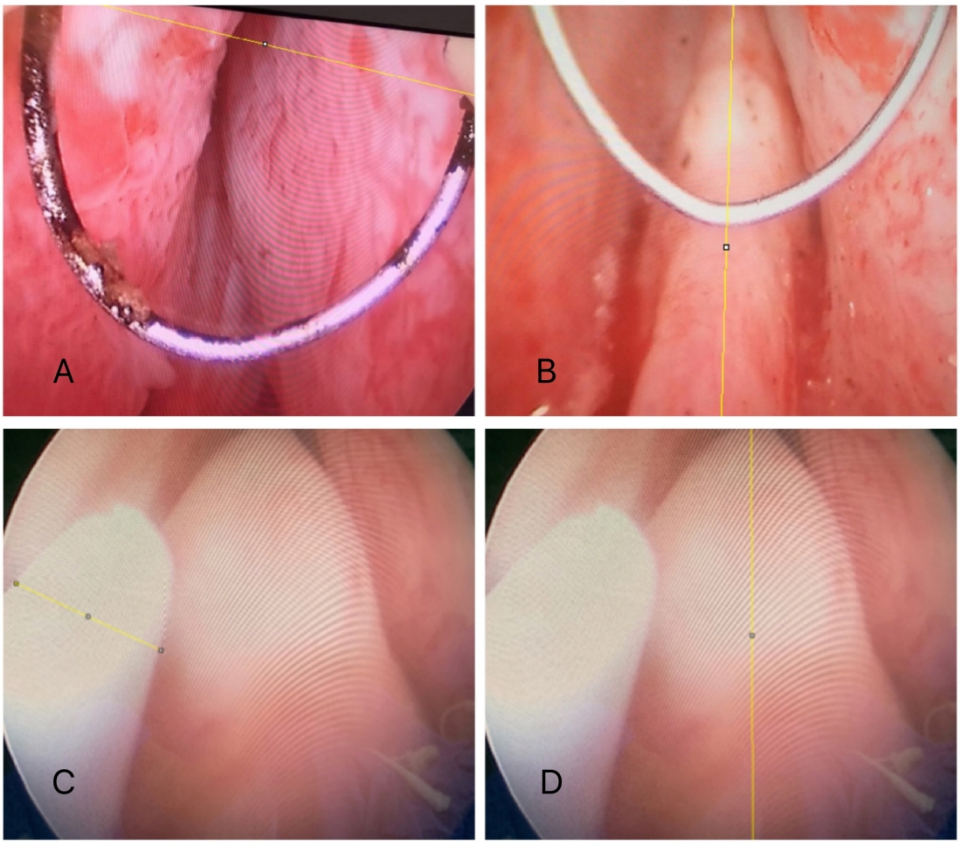


Fig 1: The figure shows the measurement of verumontanum diameters of groups 1, 2 and 3. A) Standardization of recurrent distance in groups 1 and 2 (distance between the two ends of the resection loop). B) Measurement of the longitudinal diameter of the verumontanum of groups 1 and 2. C) Standardization of the recognized distance of group 3 (ureteral catheter diameter). D) Verification of the longitudinal diameter of the verumontanum.
Source: The authors.

276x237mm (300 x 300 DPI)

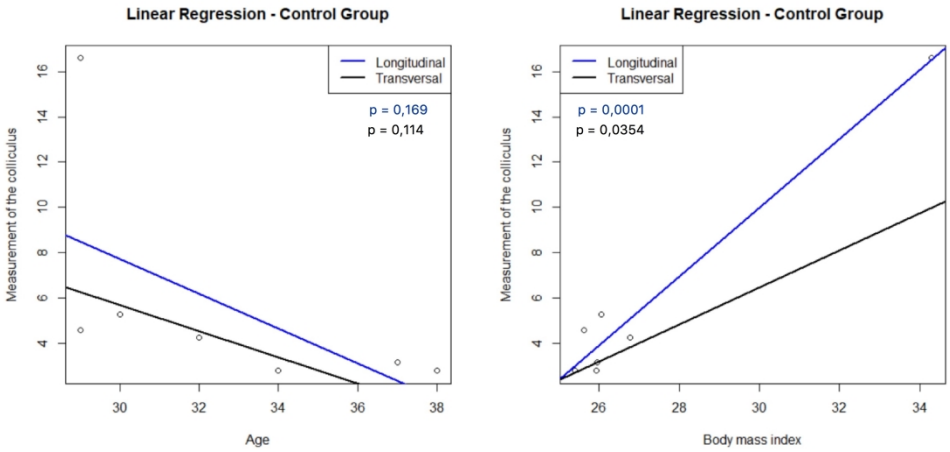


Fig 2: The figure shows the linear regression graphs of the control group comparing the age (years) and BMI (kg/m2) variables with the verumontanum measurements. Linear regression demonstrates that the longitudinal (r2 = -0.771; p = 0.169) and transverse (r2 = -0.576; p = 0.114) diameters of verumontanum decreased with age. The longitudinal (r2 = 1.521; p = 0.0001) and transverse (r2 = 0.819; p = 0.0354) diameters of verumontanum increased significantly with increasing BMI.
Source: The authors.

304x152mm (300 x 300 DPI)

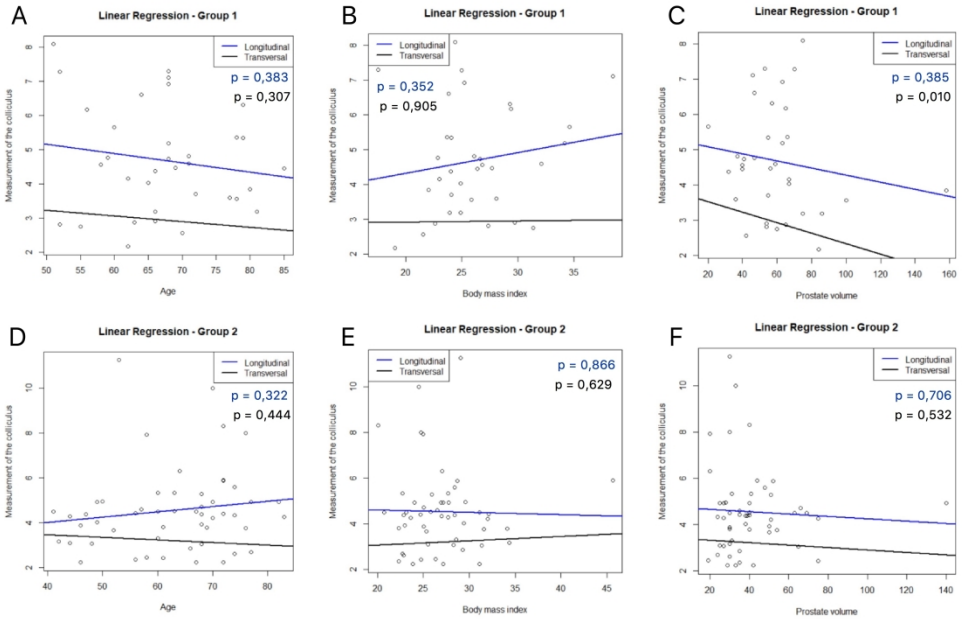


Fig 3: The figure shows the linear regression graphs of group 1 and group 2 comparing the variables age (years), BMI (kg/m2) and prostatic weight (grams) with the verumontanum measurements. Linear regression of group 1: A) With increasing age, the longitudinal (r2 = -0.022; p = 0.3833) and transverse (r2 = -0.016; p = 0.3079) diameters of the verumontanum decreased; B) There was an increase in longitudinal (r2 = 0.059; p = 0.3529) and transverse (r2 = 0.004; p = 0.9052) diameters with increasing BMI; C) There is a reduction in longitudinal (r2 = -0.010; p = 0.3850) and transverse (r2 = -0.015; p = 0.0108) diameters with increasing prostate weight. Linear regression of group 2: D) There was an increase in longitudinal diameter (r2 = 0.023; p = 0.3223) and a reduction in transverse diameter (r2 = -0.0112; p = 0.4440) with increasing age; E) There was a reduction in longitudinal diameter (r2 = -0.010; p = 0.8664) and an increase in transverse diameter (r2 = 0.019; p = 0.6291) with increasing BMI; F) There was a reduction in longitudinal (r2 = -0.005; p = 0.7060) and transverse (r2 = -0.005; p = 0.532) diameter with increasing prostate weight.
Source: The authors.

304x195mm (300 x 300 DPI)

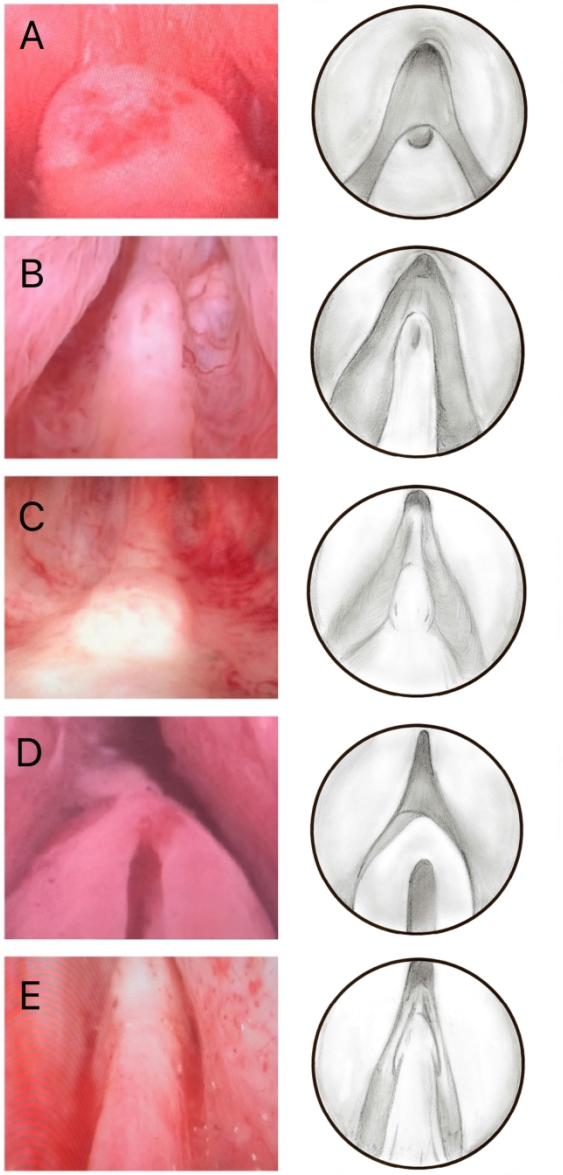


Fig 4: The figure shows the 5 types of verumontanum found in the study. The right side shows the 5 types of verumontanum during the endoscopic surgery and the left has drawings of the 5 types. A) “Volcano”. B) "Lighthouse". C) “Whale Tail”. D) "Castle Door". E) “Hood”.
Source: The authors.