Original Article

Correlation of Prostate Volume, Uroflowmetry Variables and BMI in Patients having Benign Prostatic Hyperplasia.

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Abstract

Background: *Benign Prostatic Hyperplasia (BPH) causing urinary obstruction is a common entity in a man over 40 years old. Enlarge prostate causes compression of the prostatic part of the urethra leading to bladder outflow obstruction, causes LUTs (lower urinary tract symptoms) of BPH and decreases quality of life.*

Objectives: *To find out the correlation of prostate volume, and BMI with Uroflowmetry variables, of patients having BPH symptoms.*

Materials and Methods: *A total of 44 patients having BPH symptoms, ages ranged 48 to 85 years, who underwent transabdominal ultrasound and uroflowmetry in a standing position, were included in this study. The patients were divided into 4 age groups and 4 grades of prostate size for comparison. Height in cm and weight in Kg were recorded for BMI calculation.*

Results:*Among the patients, the mean age was 66.25, with a mean prostate size of 39.73 g, with a Qmax of 14.45 ml/sec, Qave 5.96 ml/sec, mean voided volume 327.14 ml and PVR 57.91 ml with mean flow time 61 sec.In age group l, there were 3 patients, ages ranged 40 to 50 years. In age group ll, there were 11 patients, age range 51 to 60 years. In age group lll, there were 17 patients, ages ranged 61 to 70 years. In age group lV, there were 13 patients, age range 71 to 84 years. In grade l of prostate size (prostate <30 g), there were 13 patients. In grade ll prostate size (prostate 30-<50 g), there were 25 patients. In grade lll, prostate size (50-<85 g), there were 4 patients. In grade lV (prostate size is >85 g), there were 2 patients. No significant difference was found among 4 age groups and 4 grades of prostate volume. However, there was a weak correlation between prostate size and uroflowmetry variables without a significant difference.*

Conclusion: *There was a correlation between prostate volume and different uroflowmetry variables of age-related groups and grades of the prostate but the correlation was weak.*

Key words: *Benign prostatic hyperplasia, Transabdominal Ultrasound, Uroflowmetry variables*

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Introduction

Mechanical obstruction of urine flow from the urinary bladder to the outside is due to mainly prostate enlargement causing urinary retention followed by multiple complications in the urogenital system, causing decreased quality of life (QOL) of a man. Benign prostatic hyperplasia(BPH) is always confused with each other. Benign prostatic enlargement(BPE) and Bladder outflow obstruction (BOO) together causes lower urinary tract symptoms (LUTs), which is a bother symptoms, require treatment. LUTs can be subdivided into storage symptoms(eg. Urgency,frequency, nocturia etc.), voiding symptoms (straining to void, urinary intermittency, dysuria, hesitancy etc.), and third, post- voiding symptoms (eg. Sense of incomplete evacuation, post-void urinary dribbling, etc.) A portion of the urethra (about 3-4 cm in length), which is the widest and the most dilated portion of the urethra in male, traverses through the prostate from the base to the apex. If the prostate gland enlarges in size, that portion of the urethra is

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compresses by the enlarging prostatic tissue causing a few urinary problems . So, the prostate gland and urine have a big role for urinary obstruction and complications. The urine is a mixture of body waste products. Cellular metabolism generates many by-products that are rich in nitrogen and must be cleaned from the blood stream, such as urea, uric acid and creatinine. These by-products are expelled from the body as solutes in urine. If urine cannot pass out easily and smoothly, different complications arise in the body. Urine has an interesting ancient history regarding its name. Orion's name is derived from the ancient Greek word oros "mountain" or from ourios "urine". From ourios, the name Orion is derived. Orion is a famous constellation in the sky. According to the Greek Myth, Orion was a handsome giant son of Poseidon (Greek God), who has born when 3 Greek Gods-Zesus, Poseidon and Hermes urinated on a bull-hide and buried the later in the earth and then dug it up ten months later. Orion served the King Oinopion of Khios as huntsman for a time. Princess Manrope was beloved by Orion but he did not have the approval of Oenopion. Interestingly, he was blinded by Oenopion due to raping his beloved daughter princess Merope. After Orion`s death, as killed by Scorpion, both of them was placed amongst the star as the constellation of Orion in the sky. So, Orion and urine has a relation according to the Greek Mythology.[1,2] The main cell types in the prostate stroma include fibroblasts, myofibroblasst, and smooth muscle cells.[3] Multiple factors, such as hormonal imbalance, disruption of cell proliferation, apoptosis, chronic inflammation, aging, obesity, metabolic abnormalities, are thought to be responsible for the development of BPH.[4] Recent studies on BPH and carcinoma prostate (CaP) have provided significant evidence for the origin of the diseases from stem cells, that share characteristics with normal prostate stem cells. The knowledge of the prostate stem cell or stem – like cell in the development of hyperplasia will facilitate the development of new therapeutic targets for BPH and CaP (Carcinoma Prostate).[5] Bacterial infections, urine reflux, dietary factors, hormones, and autoimmune response have been considered to change inflammation in the prostate, which is a predisposing factor for BPH.[6] BPH disease-causing LUTS are usually not life threatening but can impact the quality of life. Uroflowmetry test is a simple non-invasive initial investigation that tracks how fast urine flows, how much flows out, and how long it takes . It also assesses how well the urinary tract functions. A slow flow or low flow rate may mean there is an obstruction at the bladder neck, in the urethra, a weak bladder, or an enlargement of the prostate. The size of the prostate varies from country to country. Studies have found that males in Asia, India, China, and Japan have smaller prostate volume(PV) in compare with the males in USA, and Australia.[7] According to ultrasound and radiological classification of prostate volume, where grade l size prostate is <30 g, grade ll prostate is 30-<50 g, grade lll prostate is 50-<85 g and grade lV the prostate is >85g shown in figure l.[8-10] In this study, we tried to find out the correlation between PV with Uroflowmetry variables and BMI (Basal Metabolic Index).

Materials and Methods

Mechanical obstruction of urine flow from the urinary bladder to the outside is due to mainly metabolic index) 22.54 +/-3.70 SD. The demographic data are shown in Table l.muscle cells.[3] Multiple factors, such as hormonal imbalance, disruption of cell proliferation, and neurogenic bladder were excluded from the study. The study was done on men between the ages of or stem-like cells in the development of hyperplasia will facilitate the development of new Orion served the King Oinopion of Khios as a huntsman for a time. Princess Manrope was Orion's name is derived from the ancient Greek word oros, "mountain," or from curios "urine". portion of the urethra in males, traverses through the prostate from the base to the apex. If the prostate enlargement causing urinary retention followed by multiple complications in the prostate gland enlarges in size, that portion of the urethra is compressed by the enlarging prostate is <30 g, grade ll prostate is 30-<50 g, grade lll prostate is 50-<85 g and grade lV prostatic tissue causing a few urinary problems. So, the prostate gland and urine have a big record was done and entered in proforma case sheets for analytical study. Cases diagnosed residual urine) measured by transabdominal USG, BMI was calculated. The duration of the responsible for the development of BPH.[4] Recent studies on BPH and carcinoma prostate.

Results

role for urinary obstruction and complications. Urine is a mixture of body waste products. s +/- 36 SD mean Qtmax 16.23 s +/-19.30, mean delay time 3.73 +/- 4.34 SD, mean voided SD, meanQave5.96 ml/sec+/-3.36 SD, mean flow time 61 sec +/-30 SD, mean voiding time 76.11 Share characteristics with normal prostate stem cells. The knowledge of the prostate stem cell study was from June 2018 to Nov 2018. symptoms (eg. Urgency, frequency, nocturia, etc.), voiding symptoms (straining to void, urinary the later in the earth and then dug it up ten months later. The main cell types in the prostate stroma include fibroblasts, myofibroblasts, and smooth the prostate is >85g shown in Figure l. [8,9,10] The size of the prostate varies from country to country. Studies have found that males in the sky. So, Orion and urine have a relation according to Greek Mythology. [1,2] the urethra, a weak bladder, or an enlargement of the prostate. therapeutic targets for BPH and CaP (Carcinoma Prostate). 5to the outpatient department (OPD) for LUTs susceptible to BPH were recruited. A total of 44 A uroflowmetry test is a simple, non-invasive initial investigation that tracks how fast urine flows urogenital system, causing decreased quality of life (QOL) of a man. Benign prostatic USA, and Australia.[7] variables. volume 327.14 ml +/- 162 SD, mean Post void urine (PVR) 58 +/_60.33 and mean BMI (basal with the mean prostate volume of 39.73 cm 3+/-26.53 SD with mean Qmax-14.45 ml/sec +/- 7.49

Table I: Demographic data of study population

Patients number	**44**
Age (years)	
Mean	66.25 +/- 9.24 SD
MPV (cm^3)	39.73 +/-26.53 SD
Mean Q_{max} (ml/sec)	14.45 +/- 7.49 SD
Mean Q_{ave} (ml/sec)	5.96 +/- 3.36
Mean flow time(sec)	61 +/ - 30
Mean voiding time(sec)	76.11+/- 36 SD
Mean Q_{tmax} (sec)	16.23 +/- 19.30 SD
Mean delay time (sec)	3.73 +/ - 4.34 SD
Mean voided volume (ml)	327.14 +/ -161.65 SD
Mean PVR (ml)	57.91 +/- 60.33 SD
Mean BMI (kg/m^2)	22.54+/- 3.70 SD
Duration of the study : June 2018 to November 2018	

MPV = Mean prostate volume, Qmax = maximum flow rate, Qave=average flow rate, Qtmax= time to maximum flow rate, PVR=post void residue, BMI= basal metabolic index,

Table II: Showing correlation between PV with BMI, PVR, and uroflowmetry variables (n= 44)

Pearson`s correlation test	correlation coefficient test (r)	Correlation
PV vs Q_{max}	0.0788	-ve
PV vs Q_{ave}	0.1335	-ve
PV vs flow time	0.1075	-ve
PV vs voiding time	0.0252	+ve
PV Vs Q_{tmax}	0.1875	-ve
PV vs PVR	0.0836	+ ve
PV vs BMI	0.1791	+ ve
PV vs delay time	0.0496	+ ve
PV vs voided volume	0.1694	-ve

We compared the average PV of total patients with the mean different uroflowmetry variables, Table ll shows the BMI andPVR of total patients to find out Pearson`s correlation.

Prostate volume was negatively correlated with Qmax, Qave, flow time, Qtmax, and voided volume and positively correlated with voiding time, PVR, BMI, and delay time. We divided the patients into four age groups for comparison. In Group l, 3(6.81%) patients, age ranged 40 to 50 years, in Group ll, 11(25%) patients, age ranged 51 to 60 years, in Group lll, 17(39%) patients, age ranged 61 to 70 years, in Group lV, 13(30%) patients, age ranged 71 to 84 years.

Observational comparison of four age groups is shown in Table lll:

In age Group lll, the maximum number (46%) of men suffered from BPH. Investigations revealed that mean flow time, voiding time, and Qtmax (72 +/- 38 SD, 82.31 +/- 43.65 SD, and 23.45 +/- 27.75 SD, respectively) were high in age group lll, Post void residue (PVR), and delay time (71+/- 67.24 SD, 6+/- 7.15 SD respectively) were high in age group lV, in comparison with other age groups. Qmax, Qave, and mean voided volume (18.27 +/- 9.15 SD,8.53 +/- 3.14 SD, and 493.93 +/- 93 SD, respectively) were high in age group l. The mean BMI (24.88 +/- 4.33 SD) was high in age group ll. Observational correlation of prostate volume with uroflowmetry variables, PVR and BMI of age group ll are shown in Table lV.

Table III: Showing comparison of age, PV, PVR, BMI, and uroflowmetry variables among four age groups.

Parameter	Group l (40 -50yrs)	Group ll (51 -60yrs)	GroupIII (61-70yrs)	Group lV (71 -84yrs)
No. of pts of BPH (%)	3 (6.81 %)	11 (25%)	17 (39%)	13 (30%)
Mean age(yrs)	48.33 +/-0.47 SD	58 +/- 2.22 SD	66.29 +/-3.23 SD	77.54 +/-3 SD
Mean PV.(g)	32.33 +/- 5.44 SD	34.64 +/- 12.48 SD	41.70 +/- 28.41 SD	44+/- 34 SD
Mean Q_{max} (ml/sec)	18.27 +/- 9.15 SD	11.92 +/- 5 SD	15 +/- 9 SD	16 +/- 45 SD
Mean Q_{ave} (ml/sec)	8.53 +/- 3.14 SD	5.47 +/- 2 SD	6 +/-4.18 SD	6 +/- 2.93 SD
Mean flow time(sec)	57 +/- 5 SD	59.95 +/- 23.24 SD	72 +/- 38 SD	49 +/- 19 SD
Voiding time (ml)	61.4 +/- 6 SD	74.18 +/- 27.73 SD	82.31 +/- 43.65 SD	74.41 +/- 36.13 SD
Mean Q_{tmax} (sec)	14 +/- 7 SD	13.74 +/- 11 SD	23.45 +/- 27.75 SD	9.42 +/- 4.57 SD
Mean delay time(sec)	2.67 +/- 0.47 SD	3 +/- 2 SD	3 +/- 1.49 SD	6+/- 7.15 SD
Mean voided volume(ml)	493.93 +/- 93 SD	337 +/- 162.1 SD	350 171.89 SD	261 +/- 98 SD
Mean PVR (ml)	24.67 +/- 5 SD	46.27 +/- 33 SD	65 +/- 69.36 SD	71 +/- 67.24 SD
Mean BMI (kg/m^3)	23 +/- 0.47 SD	24.88 +/- 4.33 SD	22 +/- 3.16 SD	22 +/- 3.39 SD

Table IV: Showing correlation of prostate volume with Uroflowmetry variables, PVR, and BMI in age group ll (n=11)

Pearson`s correlation test	Correlation coefficient	Correlation
P V vs Q **max**	0.0931	-ve
PV vs Q **ave**	0.1138	+ ve
PV vs flow time	0.0515	+ ve
PV vs voiding time	0.3419	+ ve
PV vs Q**tmax**	0.1203	+ve
PV vs delay time	0.5355	+ ve
PV vs VV	0.0651	+ve
PV vs PVR	0.011	+ve
PV vs BMI	0.1121	+ve

Prostate volume was weakly negatively correlated with Qmax only and weakly positively correlated with Qave, flow time, voiding time, Qtmax, delay time, VV, PVR, and BMI without significant difference. Observational correlation of prostate volume and uroflowmetry variables, PVR, and BMI of age group lll are shown in Table V.

Table V: Showing correlation of prostate volume with Uroflowmetry variables, PVR, and BMI in age group lll (n=17)

Pearson`s correlation test	Correlation coefficient	Correlation
Prost. Vol. vs Q**max**	0.0307	+ve
Prost. Vol. vs Q**ave**	0.0099	-ve
PV vs flow time	0.3084	-ve
PV vs. voiding time	0.3535	- ve
PV vs Q**tmax**	0.3108	- ve
PV vs. delay time	0.4201	- ve
PV vs VV	0.3345	- ve
PV vs PVR	0.0895	- ve
PV vs BMI	0.1101	- ve

Prostate volume was positively correlated with Qmax only but weakly negatively correlated with Qave, flow time, voiding time, Qtmax, delay time, V.V, PVR, and BMI without significant difference. Observational correlation of prostate volume and uroflowmetry variables, PVR, and BMI of age group lV are shown in Table Vl (n=13).

Table Vl: Showing correlation of prostate volume with Uroflowmetry variables, PVR, and BMI in age group lV (n=13).

Pearson`s correlation test	Correlation coefficient	Correlation
PV vs Q**max**	0.2769	-ve
PV vs Q**ave**	0.3529	-ve
PV vs flow time	0.2036	+ ve
PV vs voiding time	0.4272	+ ve
PV vs Q**tmax**	0.184	-ve
PV vs delay time	0.0818	+ve
PV vs VV	0.2369	-ve
PV vs PVR	0.1961	+ve
PV vs BMI	0.477	+ve

PV was negatively correlated with Qmax, Qave, Qtmax, VV, but weak positively correlated with flow time, voiding time, delay time, PVR, and BMI without significant difference. According to the prostate size, there were 13 patients in grade l, 25 patients in grade ll, 4 patients in grade lll, and two patients in Grade lV the prostate size is shown in Figure l.

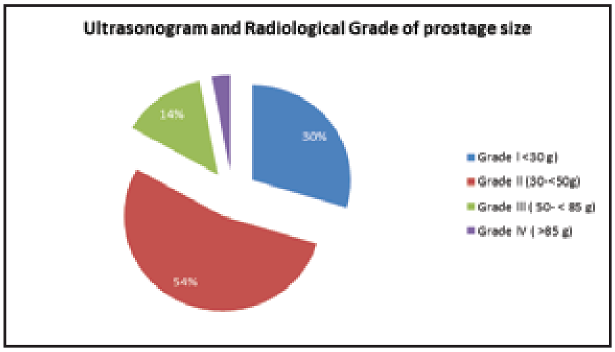

Figure l : Pie chart showing the percentage of BPH in different grades of prostate size

Observational comparison of age, PV, uroflowmetry variables, and BMI of four grades of prostate volume is shown separately in Table Vll.

As the age advanced, the prostate volume, BMI also increased, but flow time, Qtmax, VV, delay time decreased. Observational correlation of grade 1 prostate volume with Uroflowmetry variables, BMI are shown in Table Vlll.

Table Vll: Showing comparison of age, prostate size, BMI, and uroflowmetry variables

Variables(mean value) (n=2)	Grade l(n=13)	Grade ll(n=25)	Grade lll ((n=4)	Grade lV
Mean age (yrs)	66.54 +/ -8	66.16+/ 10 SD	68+/-7.12 SD	71+/-6 SD
PV (g)	21+/- 6 SD	37 +/ -5.23 SD	67+/-11.11 SD	143+/-13 SD
Q max (ml/sec)	14.12+/- SD	15+ /-8SD	15.12+/-5 SD	11.4+/-1SD
Q ave (ml/sec)	6+/ -3 SD	7.63+/-8 SD	6.23+/-2.34 SD	4+/-1.25 SD
Flow time (sec)	67.18+/-27 SD	64.102+/-32 SD	48+/-15 SD	45+/-13 SD
Voiding time (sec)	75+/-37SD	77+/ -37 SD	68+/-22 SD	78.3+/-46 SD
Q tmax (sec)	19+/-18.23 SD	17+/ -22 SD	9+/- 5 SD	6.1+/-1 SD
PVR (ml)	53.24+/-71 SD	62+/ -59 SD	40+/-20 SD	74+/-45 SD
Voided volume(ml)	335.82+/-146 SD	323.58+/-160 SD	291.6+/-99 SD	167.8+/-2 SD
Delay time (sec)	5.18 +/ -7 SD	4+/ -5.40 SD	3.5+/-2 SD	4.5+/-4 SD
BMI(kg/m3)	23+/-4 SD	22.37+/-4SD	24+/-1.30 SD	25+/-3 SD

Table VIII: Showing correlation of PV with Uroflowmetry variables and BMI of grade l prostate volume (n=13)

Pearson`s correlation test	Correlation Coefficient	Correlation
PV vs Qmax	0.2944	+ ve
PV vs Qave	0.233	+ve
P V vs Flow time	0.4055	-ve
PV vs Voiding time	0.4554	-ve
PV vs Qtmax	0.6545 moderateve (p=0.15316, sig.)	
P V vs PVR	0.0024	+ ve
PV vs BMI	0.1297	+ ve
PV vs voided vol.	0.2404	-ve
PV vs Delay time	0.1344	-ve

PV was positively correlated with Qmax, Qave, PVR, and BMI and negatively correlated with flow time, voiding time, voided volume, and delay time. Here, PV and Qtmax were moderately negatively correlated ($p < 0.05$). Observational correlation of grade ll prostate volume with Uroflowmetry variables and BMI are shown in table lX.

Table IX: showing correlation of prostate volume with Uroflowmetry variables, and BMI in grade ll prostate size (n= 25)

Pearson`s correlation test	Correlation Coefficient	Correlation
PV vs Qmax	0.2432	-ve
PVvs Qave	0.2541	-ve
PV vs Flow time	0.556	moderate + ve , significant (p<0.05)
Prost. Vol. vs V.time	0.3601	+ve
PV vs Qtmax	0.1042	+ve
PV vs PVR	0.3804	+ve
PVvs BMI	0.0552	+ve
PV vs voided volume	0.128	+ve
PV vs Delay time	0.0949	-ve

Prostate volume with Qmax, Qave, and delay time (0.2432,0.2541,0.0949, respectively) were negatively correlated without significance. Voiding time, Qtmax, PVR, VV and BMI (0.3601,0.1042,0.3804,0.128, and 0.0552, respectively) were positively correlated without significance. Prostate volume with flow time (0.556) was a moderately positively significant difference ($p<0.05$)

Discussion

An average prostate volume is approximately 20 g. An enlarged prostate is >20 g and may or may not cause urinary symptoms. BPH is a multifactorial disease. Four factors, such as family history, ethnic background, diabetes, obesity, inactivity, and erectile dysfunction, contribute to BPH.[11,12] Researchers found that hypertension aggravates the symptoms of BPH, it may increase the activity of the sympathetic nervous system. Researchers also found that high blood pressure and stress could share a common mechanism for increasing the severity of BPH. Stress triggers the release of adrenaline. The prostate and the bladder neck contain alpha receptors, that respond to adrenaline by stimulating smooth muscle cells in the prostate and bladder. When the muscle cells contract, they narrow the urethra, slowing the flow of urine and preventing the bladder from emptying completely. As the bladder becomes more sensitive to retained urine, a man may become incontinent, causing bedwetting at night or inability to micturate.[13] A new study is raising concerns that BPH medications, especially alpha-blockers may be linked to an increased risk for the development of heart failure.[14] Some authors stated that BMI is not correlated with prostate volume, some authors found a correlation of BMI with prostate volume with patients aged over 40 yrs.[15,16] Qmax and Qave values in our population were lower than that of other studies described in the literature.[17] In a study, Qmax values were significantly correlated with age and VV than Qave, but in our study, the Qmax values were positively correlated with age but negatively correlated with VV. although the difference was not significant.[18] The growth curve equations for prostate width, height and length were positively associated with increasing age. We also found the same result: as prostate volume increases as age advanced, the highest was in age group lV.[19,20] Our study showed Qmax, Qave, flow time, voiding time, delay time, and PVR gradually increased as the age advanced. BMI decreased as age advanced but the highest was in age group lll. In a study, Qmax in adult males was significantly higher than in the elderly.[21] In our study, we found Qmax was higher in age group l (40-50yrs) than in the age group lV (71-84 yrs), without significant difference. Even though the results were weak, these results are consistent with the results in other sets of populations. When the patients were divided as per their grades of prostate size, the mean prostate volume in grade l of prostate size was 21 g +/- 6.50 SD, in patients number 13, in grade ll, it was 37 g +/-5.23 SD, patients number 25, in grade lll, prostate size was 67 g +/-11.11 SD, patients number 4 and in grade lV prostate size was 143 g +/- 13 SD, patient number 2. The difference in prostate size in grade l and grade lV was significant ($p<0.001$). The prostate gland, a male accessory reproductive endocrine organ (production of DHT), is a complex ductal-acinar gland which expels proteolytic solution in the urethra during ejaculation. Epidemiologically, BPH is more prevalent in the Asia population.[21,22] Authors of a study with BPH described that, in their clinical observation and practice, many patients with smaller prostates, less than 20 grams, may cause obstruction and symptoms, as was the experience with us. Enlarge prostate causes obstruction by virtue of where the adenoma is sited. If an adenoma sitting at the bladder outlet would cause more obstruction than one site in the lateral lobe of the prostate. If an adenoma is situated middle of the prostate and protrudes into the bladder, it forms the classical median lobe obstruction due to the ball-valve effect. If the prostatic nodule is sited beneath the bladder neck, it would lift the bladder neck high and cause obstruction.[23] In a study with a median follow-up of 4.3 years, prostate size increased by 61.9% and remained stable or decreased in 38.1% of men. The result suggests that changes in prostate volume are highly variable among aging men. In our study, we found the highest prostate volume in age group lll, and a smaller volume was in group lV. As age advances few percent of the prostate may decrease in size.[24] The maximum urine flow rate of less than 15ml/sec is a risk factor of urinary retention and should be offered to prostate surgery in BPH patients.[25] In our study, only 84%had Qmax less than 15 ml/s, a candidate for prostate surgery.

Conclusion

We conclude that prostate volume is correlated with uroflowmetry variables, although there was no significant difference. Mean PV is increased as age advances. The voiding time increases as age advances and the prostate grades increase. Mean Qave decreases as age advances. Voiding time and mean delay time increase as age advances but decrease as the grades of the prostate increase. When age advances and the grades of the prostate increase, the mean voided volume decreases. When age advances, the mean PVR increases.

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