Yonsei Medical Journal
Vol. 42, No. 5, pp. 532-538, 2001

Original Article

Prostate Shape and Symptom Score in Benign Prostatic Hyperplasia

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Prostates of the same volumes were found to have very variable shapes, that is, combinations of variably elongated width, height, and lengths. These were believed to be possible causes of the differences in the severity of both the obstructions and symptoms in the prostates even when their volumes were similar. We measured the transverse (width), anterior-posterior (height) and longitudinal (length) diameters of the prostates and the transition zone, and their calculated volumes using transrectal ultrasonography. To establish the relationship between the International Prostate Symptom Score (IPSS) and each of the dimensional parameters of the transition zone and the total prostate, 105 consecutive patients (mean age 66.43 ± 9.24 years with a range o6f 46 to 90) who had voiding dysfunctions that were presumably related to BPH were analyzed using the t-test. Patients with conditions other than BPH were excluded. The results were as follows: 1. There was no significant correlation between the IPSS and any prostate volume parameter in the constant prostate volume conditions, because of the small numbers in each group. However, in the analysis of the total number of cases in all the volume categories, a significant correlation was found between the IPSS and some prostate dimensions; i.e., the longitudinal parameters in the total prostates ($p < 0.01$), and the transverse ($p < 0.05$) and longitudinal parameters ($p < 0.05$) in the transition zones. 2. Further investigations of the statistics of these significant parameters showed that prostates that were longer than 4 cm had significantly more severe symptoms than prostates shorter than 4 cm ($p < 0.05$), and that prostates with a ratio of length in the transition zone to the length in the total prostate ratio that was greater than 0.8 had significantly higher symptom scores than those with lower ratios ($p < 0.05$).

When evaluating patients who have BPH, it is important to consider the shape of prostate. More aggressive treatment may be indicated in cases where the transition zone lengths exceeds 4 cm and the transition zone to total prostate length ratio exceeds 0.8.

Key Words: BPH, prostate shape, symptom score

Received May 31, 2001
Accepted October 4, 2001

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INTRODUCTION

Although benign prostatic hyperplasia (BPH) is one of the most common disease processes affecting aging males,[1,2] its cause and effect relationships have not been well established. Three basic components are involved in the diagnosis of BPH: Hyperplasia, the symptomatology and the presence of obstruction.[3] These may appear either independently or in combination. Very weak correlations have been found between these components.[4,5] Therefore, when considering treatment, one should look for the symptoms and signs that are related to BPH, measure the enlargement of the prostate gland by digital rectal examination or by transrectal ultrasonography (TRUS), and observe decreased urine flow rate using electronic devices. This entails a huge effort, which does not always result in beneficial treatments. Additionally, when we examined the treatment methods of BPH management, some of the treatments were found to focus on the effect of symptom relief, while others were focused on obstruction relief.[6] Because of the wide variation in treatments that are available, a worldwide search to identify which candidates are best suited for specific types of treatment is underway, but as yet this remains to be clarified.

Each of the three basic components involved in the diagnosis of BPH is important in its own right, and one of the errors that can be made is to use

only one of these indicators as a measure of what is happening in the other two.[7] However, the belief that prostate size and symptoms are correlated with obstruction is unproven.[4,7] If 25-30% of patients seeking medical attention for BPH indeed do not have an obstruction, there is no reason to operate on them8,9. However, published studies did not discuss the point of the dimensional relationship between the prostate and urethra. BPH is characterized by abnormal patterns of lengthening along the three single-dimensions of the prostate, and even prostates with the same volumes can show very different enlargement shapes because of their different proliferation characteristics. However, the urethra travels in only a single direction through the three-dimensional prostate, and this could result in different symptoms and obstruction patterns, depending upon the shape of the prostate.

We undertook this study to correlate each single-dimension characteristic of a three-dimensional prostate with the symptoms scores, and attempted to identify which of these influences the symptom score.

MATERIALS AND METHODS

We studied 105 consecutive patients (mean age 66.43 ± 9.24 years with a range of 46 to 90) who had presented to collaborating urologists with symptoms that suggested BPH, and that had undergone a standard evaluation, which included the patients' self-assessment of the symptom severity, digital rectal examination, urinalysis, serum creatinine measurement, uroflowmetry, transabdominal ultrasonography of the upper and lower urinary tracts, and a transrectal ultrasonographic examination. Our investigators were also free to use any supplemental tests that were indicated for individual cases to rule out other disease processes suggested by the clinical history or the initial battery of tests. Patients were selected on the basic of symptoms of prostatism and a urinary flow rate of less than 15 ml. per second.

Symptoms of prostatism

Symptoms were scored according to one of the well-known scoring systems, the International Prostate Symptom Score (IPSS). The IPSS questionnaire, which includes one quality of life question, was self-administered by the patients. The IPSS ranged from 0 to 35 and the quality of life scores ranged from 0 to 6. Values are expressed as medians or the means plus or minus the Standard Error of the Mean or Standard Deviation. Patients with a proven or suspected neurogenic cause of their voiding dysfunction and those with prostatic or bladder cancer, or a urethral stricture were excluded from the study.

Prostate parameters and volume

Patients who were judged to be eligible for the study after this thorough evaluation were classified according to their prostate size as assessed by Transrectal Ultrasonography (TRUS), which was performed using a 7 MHz. multiplane sector scanning probe and using the prolated ellipsoid method of prostate volume measurement.[10] We measured the three single-dimension parameters of the prostate, namely, the transverse diameter (width), the anterior-posterior diameter (height), and the longitudinal diameter (length) in the transition zone and in the total prostate (Fig. 1). The ratio of the dimensional parameters in the transition zone to those in the total prostate was used to describe the dimensional characteristics of the transition zone more precisely. Prostate volume was calculated according to the following formula:

$$V = \alpha \times \beta \times \gamma \times \pi/6 \text{ (about 0.52)}$$

where α is the transverse diameter, β is a anterior-posterior diameter, and γ is the longitudinal diameter.

Cases were classified in terms of prostate volume into groups that were separated from 20 to 50 cm^3 by 10.

Statistical analysis

A statistical package, Descriptive Statistics, was used to determine the Spearman rank correlation coefficient (γ) and the coefficient of determination ($\gamma 2$) to describe the association between the prostate parameters and the IPSS for prostates of the same volume. The level of statistical

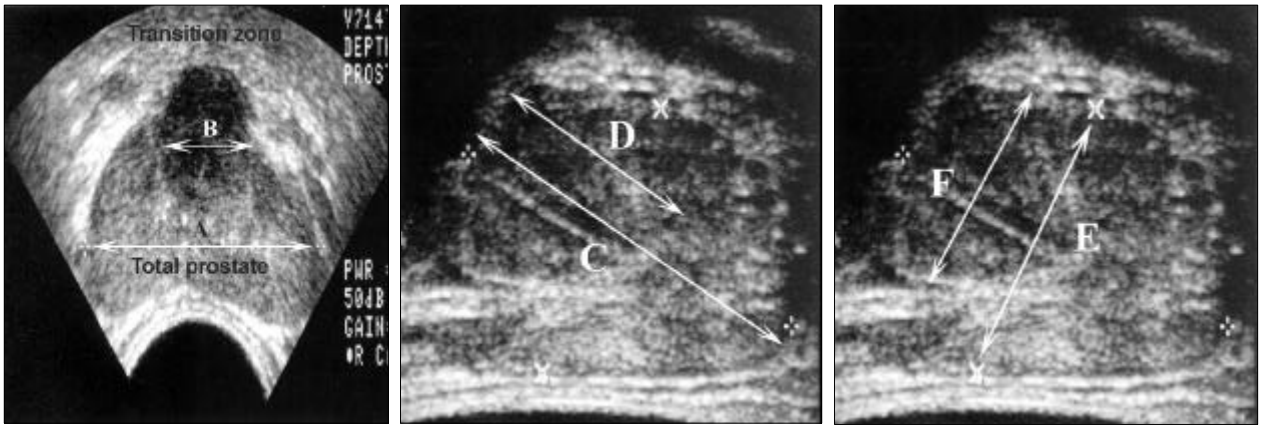

Fig. 1. The single-direction parameters of three-dimensional prostate on transrectal ultrasonography. (A) Transverse diameter of total prostate. (B) Transverse diameter of transition zone. (C) Longitudinal diameter of total prostate. (D) Longitudinal diameter of transition zone. (E) Anterior-posterior diameter of total prostate. (F) Anterior-posterior diameter of transition zone.

Table 1. Descriptive Statistics of the Patients Showing Mean Values and Ranges for the Various Parameters, which were used in the Correlation Studies with Symptom Scores

Parameters (unit)	Patients Number	Mean ± SD (range)
Age (yrs)	105	66.43 ± 9.24 (46 to 90)
Total Prostate vol. (cm^3)	105	53.13 ± 27.84 (18.08 to 152.73)
< 20 (cm^3)	2	18.28 ± 0.31 (18.08 to 18.50)
20 - 30 (cm^3)	15	25.40 ± 2.44 (21.31 to 28.38)
30 - 40 (cm^3)	25	34.19 ± 2.49 (30.05 to 39.15)
40 - 50 (cm^3)	20	44.96 ± 3.09 (40.65 to 49.96)
> 50 (cm^3)	38	79.04 ± 26.79 (50.12 to 152.73)
Transition zone vol. (cm^3)	105	19.07 ± 12.85 (3.30 to 81.17)
IPSS	105	24.19 ± 6.57 (7 to 35)
Life score	105	4.34 ± 0.91 (2 to 6)

significance was set at $p < 0.05$ (1-tailed).

RESULTS

The mean total prostate volume was 53.13 ± 27.84 cm^3 (with a range of 18.08 to 152.73 cm^3) and the mean transition zone volume was 19.07 ± 12.85 cm^3 (with a range of 3.30 to 81.17 cm^3), and these were evenly distributed according to the number of cases (Table 1). The range of prostate volume in our patients was similar to the range that was found in a community-based sample of 55 to 74 year old men in Barry's study.[4]

Three men of our patients had a prostate volume of less than 20 cm^3, compared to 5% of men in the Barry's sample. Furthermore, 79% of our men had a prostate volume of greater than 30 cm^3, which compared with 60% of the community-based men. In our study, the mean IPSS was 24.19 ± 6.57 (with a range of 7 to 35) and median quality of life score was 4.34 ± 0.91 (with a range of 2 to 6), with 85.8 % having a score of 4 or more.

Descriptive statistics with respect to the prostate parameters and IPSS are summarized in Table 1.

Characteristics of parameters in prostates of various volumes

As the total volume of prostates increased, there was a tendency for increase in each of the single-dimension prostate parameters, although different patterns of elongation were evident (Fig. 2).

In the group of men who had prostates with a volume of 20 - 30 cm^3, the three single-dimension

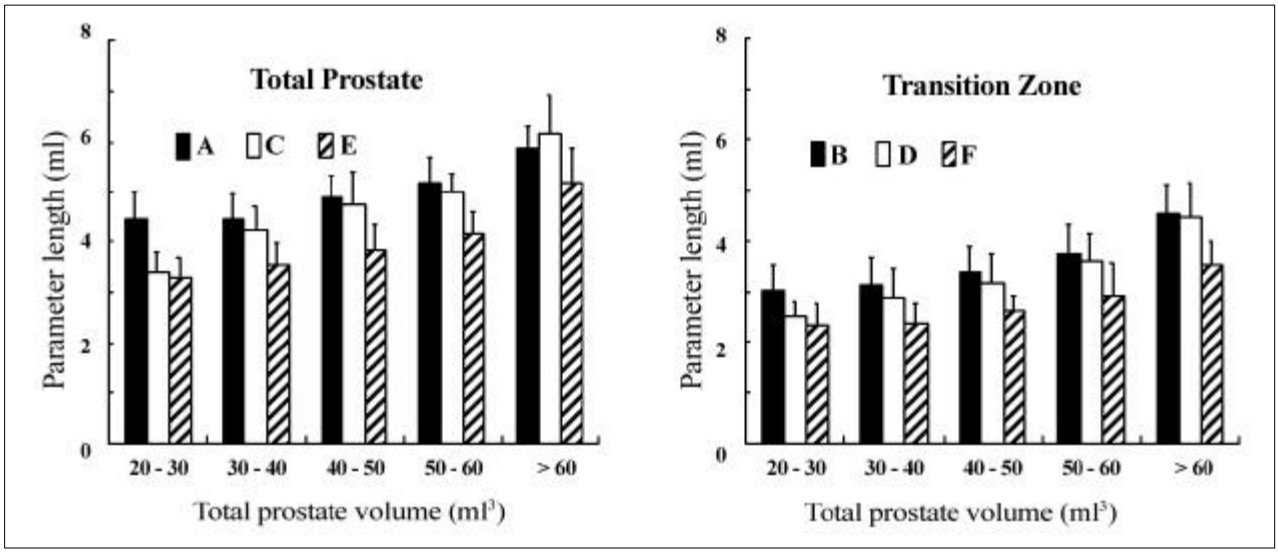

Fig. 2. The elongation patterns of the single-dimension parameters according to the various volume categories in total prostate and transition zone. Concerning the parameters of total prostate, there showed much more elongation in longitudinal parameters than those in the other parameters. This trend was present in the single-dimensional parameters of transition prostate. (A) Transverse parameter of total prostate. (B) Transverse parameter of transition zone (C) Longitudinal parameter of total prostate. (D) Longitudinal parameter of transition zone. (E) Anterior-posterior parameter of total prostate, (F) Anterior-posterior parameter of transition zone.

parameters varied between 2 and 5.5 cm with no particular value predominant. On the other hand, the group of men who had prostates with a volume of 30 - 40 cm^3, showed a similar tendency compared with the men who had prostates with a volume of 20 - 30 cm^3. As the volumes increased further, the trend towards an elongation became much more evident in the longitudinal parameters than in the other parameters.

This trend was also observed in the transition zones.

The correlation between volume parameters and symptom score

The coefficients of correlation between the selected dimensional parameters and the prostate volume are summarized in Table 2. The coefficients of determination show that the variation in the values of symptoms scores can be attributed to the variation in the parameters that were used to characterize the prostate shape. The total IPSS correlated with the quality of life score (Spearman's correlation coefficient $r = 0.40$ and $p < 0.001$). There was no significant correlation between the IPSS and the single-dimension characteristics of the prostate within the different volume categories, probably because of the small numbers in each group. However, a significant correlation was found between the total IPSS and some prostate dimensions; significant correlations were noted for the anterior-posterior parameter in the total prostates, and the transverse and longitudinal parameters in the transition zones (Table 2, Fig. 3).

Further analyses of the statistics of these significant parameters showed that prostates that were longer than 4 cm had significantly more severe symptoms than in men where the prostates were shorter than 4 cm ($p = 0.038$). Also prostates where the length in the transition zone to the length in the total prostate ratio was greater than 0.8 had significantly higher symptom scores than those prostates with lower ratios.

DISCUSSION

The correlations between the single-dimensional characteristics of the prostate and the symptoms scores remain the subjects of ongoing discussions. The reason why we looked for correlations between symptoms and these particular dimensions is that BPH is a disease that significantly impacts

Table 2. Correlation between Ipss and the Various Single-Dimension Parameters of Prostatic Shapes as Represented by Spearman Correlation Coefficients (γ) and Coefficients of Determination ($\gamma 2$)

	Parameters	γ	$\gamma 2$	p value
Total Prostate	Transverse diameter (A)	0.116	0.01	0.132
	Longitudinal length (C)	0.104	0.01	0.159
	Anterior-Posterior diameter (E)	0.176	0.03	0.044
Transition Zone	Transverse diameter (B)	0.171	0.03	0.049
	Longitudinal length (D)	0.266	0.07	0.005
	Anterior-Posterior diameter (F)	0.137	0.02	0.093

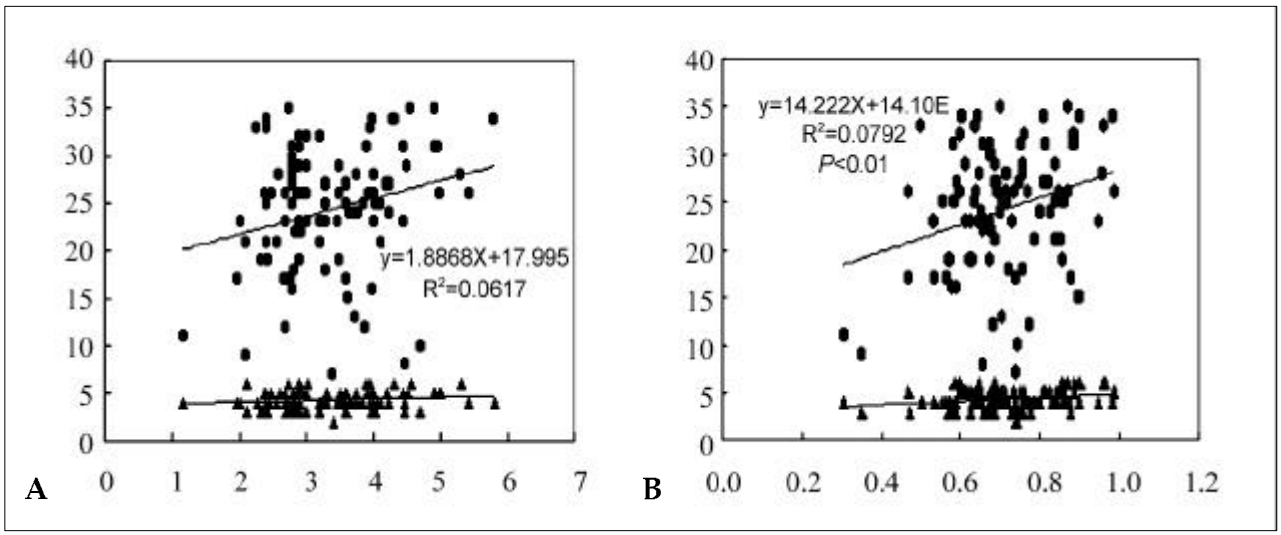

Fig. 3. Scattergram with regression line shows correlation between IPSS symptom indeces and (A) longitudinal diameter of Total prostate / (B) Ratio of transition volume to total prostate volume. ●, IPSS symptom indeces. ▲, quality of life score.

on older men's quality of life, primarily by causing bothersome urinary symptoms.[11] Accordingly, the majority of patients seek medical treatment because they would like to be relieved of these symptoms. Indeed the most common indication for intervention is based largely on the extent to which the symptoms interfere with daily activities.[12] The selection of the method of the treatment, in turn, is based primarily on the individual's view of the benefits, symptom improvement and risk of the treatment.[11] However, the symptoms of prostatism are nonspecific, and seem to be equally severe in age-matched groups of men and women, and may, at least to some extent, be related to aging. In addition these have been shown to fluctuate considerably with time and in individuals. Despite this, the urological community cannot help but accept the inclusion of symptom parameters in their objective evaluation of the treatment results, because other objective measurement methods, for example, urodynamic parameters also have many similar problems.[13] Given the central role of the symptoms in the management of patients with BPH, the interrelationships between the various levels of health in men who are thought to have BPH, can be explored by correlating their anatomic, physiologic, and health status measurements.[3,4]

A variety of treatment alternatives for those men who were diagnosed with BPH are currently available. The main goal of these treatments is to relieve the symptoms, but their main function is to relieve the obstruction. Correlations between symptoms and urodynamically proven outflow obstructions are believed to be weak,[14] and the preoperative severity of a urodynamically deter-

mined bladder outflow obstruction seems to be only a moderate predictor of the outcome, as measured by subjective symptoms and the flow rate.[15] Owing to the lack of correlations between the symptoms and other measures in BPH, it is necessary to include the presence of symptoms with other measures, such as an increased prostate volume and abnormal physiological measurements, such as the flow rate or even the post-voiding residual urine volume.[4,16]

Our study was performed to clarify one main issue, specifically, to determine the nature of the relationship, if any, between prostate volume and symptoms of prostatism in patients with BPH. Past studies have consistently shown either a weak or no correlation between the prostate size, peak urinary flow rate, residual volume, and symptom severity among men who have a clinical diagnosis of BPH.[17-19] Interestingly, Kaplan and colleagues[20] recently reported a relatively high correlation (r=0.75) between the symptom frequency, as measured by the American Urological Association (AUA) symptom index, and the transition zone index, which represents the ratio of the transition zone volume to the total gland volume. In addition, these workers found a similarly strong inverse relationship between the peak flow rates and the transition zone index. However it should be noted that both relationships were weak. In a study by Barry et al,[4] which was conducted among men who had a clinical diagnosis of BPH, no statistically significant correlation was found between the AUA symptom index and peak flow, postvoid residual, or prostate size. In addition, in a community-based study by Bosch et al,[21] the peak flow rate was modestly correlated negatively with the AUA symptom index, while the prostate size was modestly though positively correlated with the symptom level. Many experts feel that in several studies, all of which were performed upon men who had a confirmed clinical diagnosis of BPH by a urologist, also document either no, or at best a weak correlation between the presence or degree of the physiologic obstruction and the lower urinary tract symptom (LUTS) severity.[4] However, these studies lacked dimensional considerations, causing us to reconsider those results. The urethra travels in a single dimension through the three-dimensional prostate, and this could make a big difference in the interpretation of those results. To our knowledge, the present study addresses the three-dimensional relationship between the urethra and prostate. Our results show that the length of the transition zone is strongly correlated with the symptoms scores, even though the length of the total prostate is not. It would seem that the most important dimensional parameters in prostates is the longitudinal diameter of the transition zone, which travels in the same direction as the urethra. However, finding a weak correlation between the length of the total prostate and the symptom score does not disqualify these parameters from being considered or make them less useful for the characterization of BPH symptoms. The transition zone is contained in the total prostate, and the transition parameters can affect the total prostate parameters. Consequently, we studied the relationship between prostate parameters and the symptom scores in the total patients, and we attempted to define a value for the longitudinal parameter, which could make the difference in the symptom scores between groups divided by the value. We also found that patients who had a transition zone longer than 4 cm had higher symptoms scores than those who had a transition zone that was shorter than 4 cm. Moreover, when the length of the transition zone was more than 80 % of that of the total prostate, the patients showed more severe symptoms than the patients where it was less than 80%. These results explain in part the variability experienced by other investigators who noted only a weak correlation between the prostate volume and symptoms scores.

In conclusion, when evaluating patients with BPH, it is important to consider the shape of prostate, which carries statistical significance in our present study. Compared to the parameters of a 20 cm^3 prostate, in the longitudinal parameters that were more than 30 cm^3, the prostate showed a tendency of becoming longer than the other parameters as the volume grew. More aggressive treatment may be indicated in cases where the transition zone lengths exceeds 4 cm and the transition zone to total prostate length ratio exceeds 0.8.

But future research should provide a better

understanding of this relationship by including more cases, and will make a valuable contribution to our understanding of the pathophysiology of the voiding dysfunction in men who have symptoms of prostatism.

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