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SIGNIFICANCE OF TESTICULAR SIZE MEASUREMENT IN ANDROLOGY: II. CORRELATION OF TESTICULAR SIZE WITH TESTICULAR FUNCTION

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ABSTRACT

The testicular sizes of 305 men were measured by a recently developed orchidometer and related to 9 other known parameters of testicular function. Mean testicular size had the strongest correlation with serum follicle-stimulating hormone levels, total sperm count and sperm concentration, while a significant correlation also was noted with sperm motility, percentage of live sperm, sperm morphology (normal and immature forms), and serum luteinizing hormone and testosterone levels. Sperm quantity had stronger correlations with testicular size than did sperm quality, although both were impaired in testes smaller than 14 ml. It is concluded that the size of the testis bears a direct correlation with testicular function and, thus, it can be helpful to assess rapidly andrological status during the initial physical examination.

Testicular size generally is supposed to correlate well with semen quality and fertility.[1] However, what specific parameters of testicular function correlate well with testicular size presently are unknown. Indeed, it is not known if testicular size is dependent on Leydig cell function or if it only has a good correlation with seminiferous tubular function. Is it correlated with only sperm quantity or also with sperm quality? What is the critical testicular size that indicates normal testicular function for the parameters? Surprisingly, there have been few systematic investigations to answer these questions. One obstacle has been the absence of a rapid and reproducible means of determining testicular size accurately.

The purpose of this study was to determine the correlation of testicular size, as measured by a new orchidometer,[2] with seminiferous tubular function (sperm quantity and quality, and serum follicle-stimulating hormone) and Leydig cell function (serum luteinizing hormone and testosterone) in a large population of men. Also we noted the critical testicular size above which each parameter of testicular function was within normal limits.

MATERIALS AND METHODS

With the elliptical orchidometer we documented the difference of semen quality relative to mean testicular size in 305 men between 24 and 50 years old (average age 28.8 years) for evaluation of a possible male factor in an infertile couple attending our andrology clinic. Patients with concomitant infections, cryptorchidism and ductal obstruction were excluded from the study. The means of data from 3 separate semen evaluations were used to establish the values presented. Semen analysis was performed in our laboratory according to methods reported previously.[3]

The selection of patients for hormonal assessment was random with approximately 27 per cent of the patients being assessed for serum follicle-stimulating hormone, luteinizing hormone and testosterone concentration. Determination of these hormones was done with double-antibody radioimmunoassay kits.†

Correlation coefficients were calculated between mean testicular size (left and right), and each serum and semen parameter was examined using Pearson's product-moment coefficient. Data were transformed when necessary to obtain a normal distribution. In addition, each parameter measured was grouped according to mean testicular size and compared to the normal range for that parameter. The data for each parameter were analyzed for differences among groups using analysis of variance, followed by Fisher's test for least significant difference. Statistical analyses were done with a Digital model 10 computer and a Minitab statistical software package.[4]

RESULTS

Sperm concentration. A significant positive correlation ($r = 0.522$, $p < 0.01$, $n = 305$) was found between mean testicular size and sperm concentration (see table). Furthermore, when patients were grouped by testicular size sperm counts were noted to decrease to subnormal levels in those with a testicular size of less than 14 ml. (fig. 1, *A*). When compared to patients with a testicular size of greater than 20 ml. sperm counts were significantly lower than in any other testicular size groups. The patients with testicular sizes of 16 to 20 ml. exhibited sperm counts that were significantly higher than those whose testicular size was less than 14 ml. Indeed, patients with a testicular size of 10 to 14 ml. showed mild oligospermia on the average with a few in the normal range, while those with a testicular size of less than 10 ml. showed oligospermia or azoospermia (fig. 1, *A*).

Correlations of mean testicular size with parameters of testicular function

Parameter	No. Pts.	Correlation (r)	Slope (m)	Significance (p)
Sperm concentration	305	0.522	0.632	<0.01
Total sperm count	305	0.566	0.373	<0.01
Sperm motility	304	0.400	0.042	<0.01
% live sperm	305	0.392	0.095	<0.01
% normal sperm	268	0.262	0.001	<0.01
% immature sperm	277	−0.320	26.40	<0.01
Serum follicle-stimulating hormone	88	−0.589	21.50	<0.01
Serum luteinizing hormone	80	−0.376	22.50	<0.01
Serum testosterone	74	0.295	3.31	<0.01

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† Serono Diagnostics, Inc., Randolph Massachusetts.

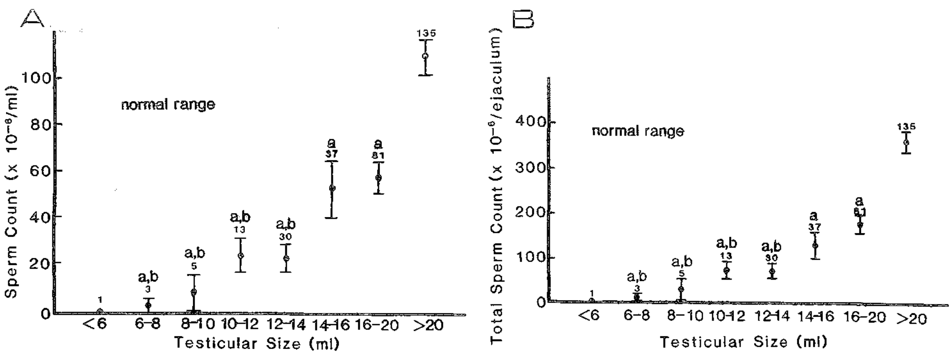

FIG. 1. *A*, relationship of sperm count to testicular size. *B*, relationship of total sperm count per ejaculum to testicular size. *a*, significantly different from patients with testicular size greater than 20 ml. ($p < 0.05$). *b*, significantly different from patients with testicular size of 16 to 20 ml. ($p < 0.05$).

Total sperm count per ejaculum. A stronger positive correlation ($r = 0.566$, $p < 0.01$, $n = 305$) than that with sperm concentration and testicular size was found between total sperm count per ejaculum and mean testicular size (see table). We noted that those patients with a testicular size of less than 14 ml. typically showed total sperm counts below normal limits (fig. 1, *B*). When compared to patients with a testicular size greater than 20 ml. all other size groups showed significantly fewer sperm per ejaculum. Furthermore, the patients with a testicular size of 16 to 20 ml. produced significantly more sperm per ejaculum than those with testes smaller than 14 ml. (fig. 1, *A*).

Sperm motility score. We also noted a positive correlation ($r = 0.400$, $p < 0.01$, $n = 304$) between mean testicular size and sperm motility score (see table). Sperm motility scores of those patients with a testicular size of greater than 20 ml. were significantly higher than any other group (fig. 2). Patients with a testicular size of less than 14 ml. showed significantly lower motility scores compared to those whose testicular size was between 16 and 20 ml.

Live sperm. A significant positive correlation ($r = 0.392$, $p < 0.01$, $n = 305$) also was found between percentage of live sperm and mean testicular size (see table). The percentage of live sperm generally was observed to be subnormal in patients with a testicular size of 14 to 16 ml. The percentage of live sperm in patients with a testicular size of greater than 20 ml. was significantly higher than that of all other size groups (fig. 3). Furthermore, this parameter was significantly lower in patients with a testicular size of less than 14 ml. when compared to the 14 to 16 ml. group.

Normal sperm morphology. With respect to the percentage of normal sperm, mean testicular size also had a significant positive correlation ($r = 0.262$, $p < 0.01$, $n = 268$) (see table). However, this correlation did not exist when the testes were greater than 10 ml. The percentage of normal sperm also was significantly lower in patients with a testicular size of less than 14 ml. when compared to those with larger testes (fig. 4, *A*).

Immature sperm morphology. Mean testicular size had a significant negative correlation ($r = -0.320$, $p < 0.01$, $n = 277$) with percentage of immature sperm (see table). This correlation was particularly strong in patients with a testicular size of greater than 12 ml. Conversely, no such correlation was observed in patients with a testicular size of less than 12 ml. The percentage of immature sperm generally was observed to be outside the normal range in patients with a testicular size of less than 16 ml. (fig. 4, *B*). Indeed, nearly every group of patients with a testicular size of less than 16 ml. had significantly more immature sperm forms than those with larger testes.

Sperm follicle-stimulating hormone. There was a strong negative correlation ($r = -0.589$, $p < 0.01$, $n = 88$) between mean testicular size and serum follicle-stimulating hormone levels (see table). Serum follicle-stimulating hormone showed a trend to be abnormally high in patients with a testicular size of 16 ml. or less (fig. 5). However, only the 8 to 10 ml. group showed statistically higher follicle-stimulating hormone levels than any groups with a mean testicular size of greater than 12 ml.

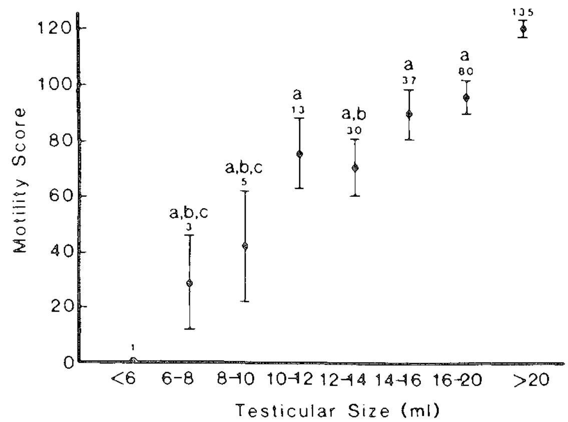

FIG. 2. Relationship of sperm motility to testicular size. *a*, significantly different from patients with testicular size greater than 20 ml. ($p < 0.05$). *b*, significantly different from patients with testicular size of 16 to 20 ml. ($p < 0.05$). *c*, significantly different from patients with testicular size of 14 to 16 ml. ($p < 0.05$).

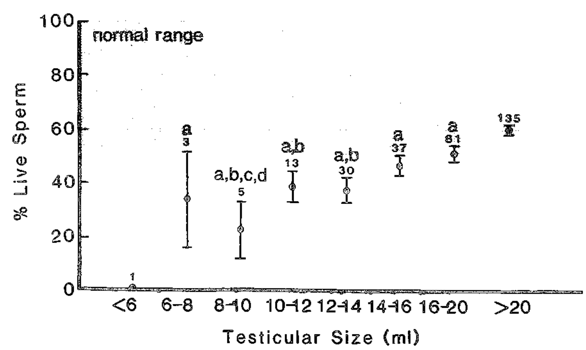

FIG. 3. Relationship of percentage of live sperm to testicular size. *a*, significantly different from patients with testicular size greater than 20 ml. ($p < 0.05$). *b*, significantly different from patients with testicular size of 16 to 20 ml. ($p < 0.05$). *c*, significantly different from patients with testicular size of 14 to 16 ml. ($p < 0.05$). *d*, significantly different from patients with testicular size of 12 to 14 ml. ($p < 0.05$).

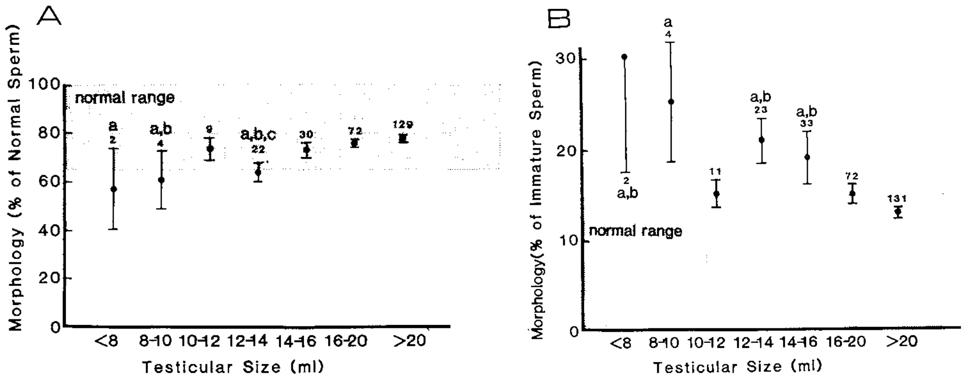

FIG. 4. *A*, relationship of percentage of normal sperm morphology to testicular size. *B*, relationship of percentage of immature sperm morphology to testicular size. *a*, significantly different from patients with testicular size greater than 20 ml. ($p < 0.05$). *b*, significantly different from patients with testicular size of 16 to 20 ml. ($p < 0.05$). *c*, significantly different from patients with testicular size of 14 to 16 ml. ($p < 0.05$).

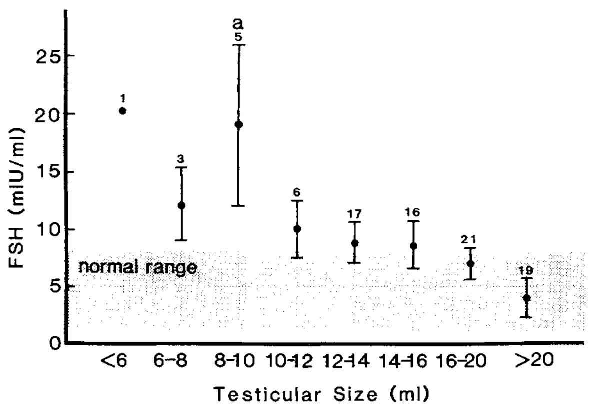

FIG. 5. Relationship of serum follicle-stimulating hormone to testicular size. *a*, significantly different from patients with testicular size greater than 12 ml. ($p < 0.05$).

Serum luteinizing hormone. There also was a significant negative correlation ($r = -0.376$, $p < 0.01$, $n = 80$) between mean testicular size and serum luteinizing hormone levels (see table). However, serum luteinizing hormone levels showed a trend to be increased only in patients with a testicular size of less than 10 ml. (fig. 6, *A*).

Serum testosterone. Finally, we found a significant positive correlation ($r = 0.295$, $p < 0.01$, $n = 74$) between mean testicular size and serum testosterone levels (see table). Serum testosterone levels were below the normal limit only in patients with a testicular size of less than 12 ml. (fig. 6, *B*). Furthermore, the patients had significantly lower serum testosterone levels than those whose testes were greater than 12 ml.

Other parameters. No significant correlations were found between mean testicular sizes and percentage of tapered sperm form, seminal zinc or seminal calcium concentrations.

DISCUSSION

Generally, it is believed that the testicular size is the best primary assessment of spermatogenesis in the andrology clinic, since the tubules and germinal elements account for approximately 98 per cent of the testicular mass. A reduction in the number of germ cells understandably leads to testicular hypoplasia.[1] Thus, sufficient spermatogenesis is presumed to be only possible in a testis of normal or near normal size. It also has been presumed that normal Leydig cell function can be preserved even with a testis that is small.[1] Surprisingly, few studies have been done to determine the critical testicular sizes for normal seminiferous tubules and Leydig cell function. To our knowledge there has been only 1 previous report of data regarding sperm count in relation to testicular size as measured by an echogram.[4] In that study sperm counts of less than 30 million per ml. corresponded to a significant decrease in the mean testicular width. For a group of patients whose sperm counts exceeded 50 million per ml. the authors observed a mean echographic width of the testes of 2.23 cm., whereas for a group of patients with azoospermia mean testicular width was 1.55 cm. Thus, they concluded that the size of the testis bears a direct relationship to the number of sperm produced.

However, for routine clinical use a more convenient measurement technique would be beneficial. Measurements of testicular sizes were obtained with a punched-out orchidometer as reported previously.[2] With this convenient and accurate technique we demonstrated the strongest correlations of testicular size to be with serum follicle-stimulating hormone levels, total sperm counts and sperm counts per ml. (see table). A good correlation of testicular size also was noted with sperm motility, percentage of live sperm, sperm morphology, and serum luteinizing hormone and testosterone levels. Thus, this systematic investigation has shown the correlation of testicular size and semen parameters along with serum follicle-stimulating hormone, luteinizing hormone and testosterone levels. Serum follicle-stimulating hormone levels had the strongest negative correlation with testicular size, which is in keeping with the idea that the germinal elements are responsible for the negative feedback mechanism increasing follicle-stimulating hormone levels.[5] Total sperm count had a strong positive correlation with testicular size. Thus, sperm production, that is sperm quantity, was shown to be impaired moderately when mean testicular size was less than 20 ml.

Not only sperm quantity but also sperm quality (motility, percentage of live sperm and morphology) was shown to have correlations with testicular size, although these correlations were not as strong as those with the quantity of sperm. This might be owing to the fact that sperm quality is related to some extent to male accessory sex gland functions. Our data indicate that the critical value of mean testicular size for normal or near normal sperm quality and quantity is 14 ml.

Serum luteinizing hormone and testosterone levels proved to be out of the normal ranges only when testicular size was smaller than 10 or 12 ml. These findings indicate that Leydig cell function can be preserved in a testis that is relatively small. However, if the testis is smaller than about 12 ml. seminiferous tubule and Leydig cell function could be impaired.

It is concluded that the size of the testis bears a significant correlation with many parameters of testicular function and, thus, it can be helpful to assess rapidly andrological status during the initial physical examination.

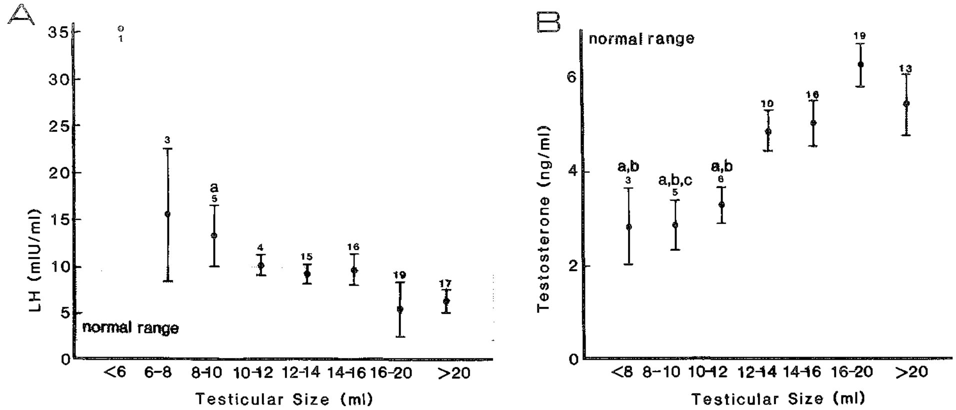

FIG. 6. *A*, relationship of serum luteinizing hormone to testicular size. *B*, relationship of serum testosterone to testicular size. *a*, significantly different from patients with testicular size greater than 20 ml. ($p < 0.05$). *b*, significantly different from patients with testicular size of 16 to 20 ml. ($p < 0.05$). *c*, significantly different from patients with testicular size of 14 to 16 ml. ($p < 0.05$).

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