Original Research Article

Assessment of mean testicular volume in adolescent school boys of Udaipur district in 10 to 18 years at different stages of pubertal development

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ABSTRACT

Background: The most obvious and important changes during puberty are secondary sexual characters. To check the correlation between testicular volumes with secondary sexual characters, nutritional status in Udaipur schoolboy's assessment of testicular volume by prayer orchidometer is easy and reliable and accurate method in community. Aim of the study was to find out mean testicular volume by prader orchidometer at different stages of pubertal development.
Methods: Children between 10 to 18 years of age (525 in numbers) from schools of Udaipur city were included. Children thoroughly examined for presence of any systemic disorders or major surgery was excluded. Informed consent with parents was taken Testicular volume assessment done by praders orchidometer with Tanner staging and correlation was statically analysed.
Results: Maximum boys belonged to 15-16 years of age group (14.7%), and minimum belongs to 10-11 years age group (9.3%). Secondary sexual characters increases as mean testicular volume increases. The mean testicular volume for P1 (4.46 ml) and P5 (22.68 ml) and G1 (4.69 ml) and G5 (23.27 ml) with a p<0.05.
Conclusions: Testicular volume adds more objectivity in SMR detection and helps to differentiate early genital maturation than pubic hair. Study population had early rise of testicular volume before pubic hair clinically visible which shows that testicular volume is the first to increase with the onset of puberty.

Keywords: Body Mass Index, Genital stage, Pubic hair stage, Tanner staging, Testicular volume

INTRODUCTION

Puberty is defined as period when endocrine and gametogenic functions of gonads have first developed to the point where reproduction is possible.[1] Testicular volume is the earliest indicator of puberty in adolescent boys. According to Kaplan boys' pubertal status can be accurately determined by testicular volume at a much earlier stage. Early assessment may be particularly important in a situation where "normal" pubertal staging may be changing due to environmental or other unknown factors. The variability in behavior problems in adolescence, particularly in boys has profound psychological and social consequences e.g. boys developing early will be stronger and more athletic than other boys.[2] Whereas late developers may be frustrated by their lack of physical and sexual development.[3]

In this study authors assess the bodily changes of sexual maturation rather than the psychosocial and cultural aspects of adolescent development. Puberty is initiated by hormone signals from the brain to gonads. In response gonads produce variety of hormones that stimulate growth and development of brain, bones, muscle, skin,

breast and reproductive organs. The most obvious and important changes during puberty are secondary sexual characters.

Various factors like time of onset, genetic factors, ethnic/race, physical activity and Exercise, stress and social factors affect puberty. Nutrition is strongest environmental factors affecting puberty. Critical body weight must reach for puberty to occur.[4-6] This energy balance regulates the activity of hypothalamic GnRH pulse generator acting via hormonal signals. Childhood obesity results in early puberty although surplus energy has not important influence on time of puberty, lower protein and higher plant fibers delay and slows the progression of female puberty.

A high level of exercise reduces energy calories available for reproduction and slows puberty. Impact of stress and social factors is well known but ill understood. Intense psychological stress delay puberty as in war times. Improve nutritional and body mass seems to be the most important contributors of early sexual maturity. Frisch et al have shown that critical amount of fat mass is needed for the onset of puberty. With urbanization, sedentary lifestyle and improving nutrition, there is sharp rise in urban obesity in India.

Physical development of puberty in boys is best described by James Mourilyan Tanner and bears his name called Tanner SMR (Sexual maturation rating). SMR is best and easy to perform. SMR staging is supported with other physical findings like axillary hair, facial hair, and acne. A classic determination of onset of puberty is a testicular length >2.5 cm or volume greater than 4 ml. Objective of my study is to check the effect of nutritional status (BMI) on testicular volume and to find out mean testicular volume by prader orchidometer at different stages of pubertal development.

METHODS

The present cross-sectional study was carried out at the schools of Udaipur District Rajasthan India. Study was conducted during one year (May 2018-May 2019), after obtaining permission from ethical committee of institute. The Paediatric Department of Geetanjali Medical College and hospital is involved in this study.

Inclusion criteria

- Children between 10 to 18 years of age of approximately 587 boys are from various schools of Udaipur city. Selection criteria from each school were age wise. I examined the children until 525 sample sizes were reached. I have divided the schools of Udaipur sector wise, and in each sector I visited schools and took the permission from school principal and told the importance of my study and at a time 6 to 7 children were examined completely with testicular volume measurement by me.

Informed written consent was obtained from parents of each patient. All these cases were subjected to detailed history, physical examination, testicular volume assessment with prader orchidometer.

$$n = \frac{(So/2 + Z1 - \beta) \ P(1-P)}{E^2} = 525$$

Exclusion criteria

- Children were thoroughly examined for presence of any systemic disorders like Mumps, Hypothyroidism, Diabetes mellitus, Trauma, Vasculitis any drug intake like glucocorticoids, ketoconazole, testicular atrophy or major surgery like Hernia which can affect their growth and some parents didn't give verified informed consent for complete physical examination of their children so 62 children were excluded.

Age and date of birth were asked to children and reconfirmed from school record. Examination of children done by me without any error which roughly corresponds to 50-60 children per month after talking with school principle Weight was recorded on digital weight machine without shoes. Height was obtained with stadiometer. Detailed dietary history was taken from adolescents' schoolboys of Udaipur. Their nutritional status was classified as Normal underweight, overweight, obese according to BMI. The term overweight is used when BMI exceeds the 85th percentile for the age and sex and obesity is used when BMI exceeds 95th percentile for age and sex.

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) for MS Windows. The obtained data was entered into MS Excel. The data was analysed using descriptive statistics, chi square.

RESULTS

Out of total 525 boys, maximum boys belonged to 15-16 years of age group (14.7%), and minimum belongs to 10-11 years age group (9.3%). Above number of children are due to availability of children in particular age group in school. The mean testicular volume was minimum for 10-11 years (4.67 ml) and was maximum for 17-18 years age group (23.71ml) with a p<0.05.

From 525 boys, 13 (2.47%) boys belonged to pubic hair stage 1, 139 (26.4%) boys belonged to pubic hair stage 2, 128 (24.3%) boys belonged to pubic hair stage 3, 134 (25.5%) boys belonged to pubic hair stage 4 and the remaining 111 (21.1%) boys belonged to pubic hair stage 5.The mean testicular volume was minimum for p 1(4.46 ml) and was maximum for P5 (22.68 ml) with a p<0.05 (Table 2).

Table 1: Distribution of children according to mean testicular volume.

Age-group (Years)	Number of children	Mean testicular volume (ml)	Std. deviation	p-value
10-11	49	4.67	1.04	
11-12	60	7.82	3.41	
12-13	59	8.54	3.12	
13-14	73	12.40	3.02	≤ 0.05
14-15	66	13.85	3.69	
15-16	77	15.84	4.05	
16-17	65	20.38	3.45	
17-18	70	23.71	2.20	

Table 2: Correlation between mean testicular volume and pubic hair stage.

Pubic hair stage	Number of children	Mean Testicular Volume (ml)	Std. Deviation	p-value
1	13	4.46	0.776	
2	139	6.60	2.013	
3	128	11.83	2.235	≤0.05
4	134	17.60	4.062	
5	111	22.68	2.851	
Total	525	14.03	6.736	

Out of 525 boys, 45(8.57%) boys belonged to genital stage 1, 130 (24.7%) boys belonged to genital stage 2, 138 (26.2%) boys belonged to genital stage 3, 111 (21.1%) boys belonged to genital stage 4 and the remaining 101 (19.2%) boys belonged to genital stage 5. These genital stages clinically correlate with Tanner staging. The mean testicular volume was minimum for G1(4.69 ml) and was maximum for 5(23.27 ml) with a p<0.05 (Table 3).

Table 3: Correlation between mean testicular volume and genital stage.

Genital stage	Number of children	Mean testicular volume (ml)	Std. deviation	p-value
1	45	4.69	.973	
2	130	7.64	2.306	
3	138	12.75	2.414	≤0.05
4	111	18.50	3.411	
5	101	23.27	2.592	
Total	525	14.03	6.736	

Mean weight of Udaipur children according to genital stage were G1 (37.4 kg) G2 (42.8 kg), G3 (44.95 kg), G4 (45.9 kg), G5 (52 kg).

Mean height of Udaipur children according to genital stage were G1 (143.3 cm) G2 (149.19 cm), G3 (154.03 cm), G4 (154.71 cm), G5 (162.59 cm). Classification of

nutritional status is according to age related percentile charts for BMI, out of 525 boys, 145 boys (27.6%) were underweight, 371 boys (70.7%) had normal weight, 8 boys (1.5%) were overweight and the remaining 1 (0.2%) patient was obese.

Mean testicular volume in underweight children was 11.13 ml, Overweight children 15.25 ml, Obese children 20 ml , Normal children 15.12 ml with minimum mean testicular volume for underweight (11.13 ml) and was maximum for obese (20.0 ml) with a p<0.05 as shown by (Table 4).

Table 4: Correlation between mean testicular volume and BMI.

BMI	Number of children	Mean Testicular Volume (ml)	Std. deviation	p-value
Under weight	145	11.13	5.292	
Normal	371	15.12	6.934	
Over weight	8	15.25	5.874	≤.05
Obese	1	20.00	.	
Total	525	14.03	6.736	

Table 5 shows the distribution of 525 children according to mean BMI between different age groups and genital stages. Mean BMI according to genital stage of Udaipur children were G2 (19.1 kg/m^2), G3 (18.87 kg/m^2), G4 (19.33 kg/m^2), G5 (19.73 kg/m^2).

Table 5: Mean BMI between age group and genital stage.

Age in Years	Genital Stage				
	1	2	3	4	5
10-11	18.64	18.53	-	-	-
11-12	17.60	17.99	18.60	19.56	-
12-13	18.70	19.51	18.58	15.49	-
13-14	-	20.29	18.87	21.55	-
14-15	-	19.59	18.22	19.08	19.25
15-16	-	-	18.11	18.38	18.11
16-17	-	-	20.85	20.14	20.22
17-18	-	-	-	21.13	21.34
Mean BMI	18.31	19.1	18.87	19.33	19.73

Out of total 525 boys, facial hair was present in 168 (32%) of the boys, the mean testicular volume was higher for cases with facial hairs (16.09 ml) with a p<0.05 (Table 6). Axillary hair was present in 286 (54%) boys, the mean testicular volume was higher for cases with axillary hairs (17.43 ml) with a p <0.05 (Figure 1).

Acne was present in 331 (63%) boys, the mean testicular volume was higher for cases with Acne (16.29 ml) with a p<0.05.

Table 6: Correlation between mean testicular volume and facial hair.

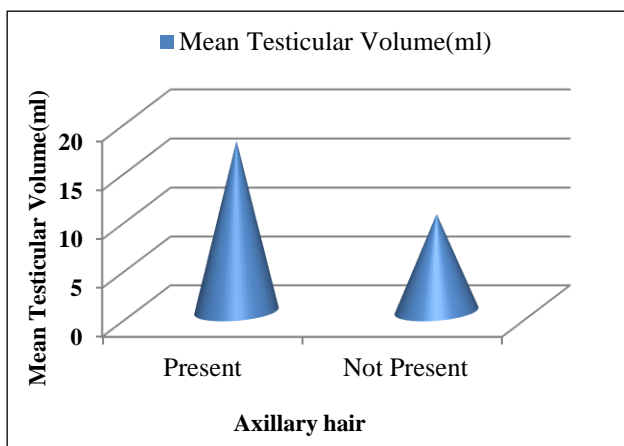| Facial hair	Number of children	Mean testicular volume (ml)	Std. deviation	p-value
Present	357	16.09	6.325	<0.05
Not present	168	9.65	5.356	
Total	525	14.03	6.736	

Figure 1: Correlation between mean testicular volume and axillary hair.

From the above data Udaipur children had early maturation of genital organs or firstly testicular volume increases then secondary sexual characters appear.

DISCUSSION

In Marshall and Tanner studies genitals begin to develop between the ages 13.5 years in 95% of boys and reached maturity at the age between 15 to 17 years.[7] In the present study authors measure mean testicular volume at each genital stage and pubic stage which correlate that genitals begin to develop at age of 11.5 to 12 years one to two years earlier than the development according to Marshall and tanner, this so that Marshall and tanner takes only nude photographs of each boy and they did not determine the exact appearance of pubic hair, they did not measure testicular volume for determining secondary sexual characters.

Marshall and Tanner et al, studies shows that pubic hair appear in pubic stage 2 and genital changes begin from G2 but from this study authors concluded that mean testicular volume is 4.5 ml at genital stage 1 and pubic hair stage 1 which concluded that testicular volume enlargement is the first sign of pubertal onset after which changes appear in pubic hair and scrotum.[7]

Gaete X et al, studies also shows that testicular enlargement occurs one year earlier than changes in genitalia. According to inspection pubertal onset occurred

at 10.2±1.5 years according to TV and at 11.1±1.6 years according to GI (p<0.01). Before the age of nine, 15.2% of children had a VT ≥4 ml, 3% had genital changes in GI and only 3% had both changes simultaneously.[8]

In the present study mean weight (kg) were 42.8, 44.95, 45.9, 52 from G2 to G5 in contrast to mean weight of 38, 42.5, 46.8, 52.9 for genital stages G2 to G5 in Agarwal et al.[9]

Similarly, in present study mean height (cm) from G2 to G5 were 149.19, 154, 154.71, 162.59 which are in accordance with standards given by Agarwal et al, 150, 155.8, 161.2, 165.2 from G2 to G5.[9] They studied both boys and girls and their sample size is larger compared to present study which included only boys and sample size is not large.

In the present study 68% schoolboys shows presence of facial hair in which mean testicular volume is 16.09 ml. This mean testicular volume correlates well between genital stage 3 and 4 and pubic hair stage 3 and 4. This mean testicular volume and correlation between genital stage and pubic hair is correlated with Agarwal et al, study.[9]

In the present study authors concluded that mean testicular volume is 17.43 ml which is suggestive of onset of axillary hair while in this study maximum axillary hair present in genital stage 4 and pubic stage 4, Agarwal et al, by their own study shows that axillary hair maturation present in genital stage 5.[9]

From present study authors confer that acne during pubertal onset present mainly during genital stage 4 which has correlation with mean testicular volume of 16.29 ml. Agrawal et al, also shows that incidence of acne was only 7% in G2 to 58% in G4, G5 stage.[9]

Similarly Aris IM et al, shows in both Belarusian and US children, higher BMI z scores in infancy and childhood were associated with faster length and height velocity in early life, while higher BMI z scores during middle childhood were associated with slower length and height velocity during adolescence.[10]

Mean BMI according to genital stage of Udaipur children were G2(19.1 kg/m^2), G3(18.87 kg/m^2), G4(19.33 kg/m^2), G5(19.73 kg/m^2). Similar findings shown by Dr. Joycee. M. Lee Boys in the highest BMI trajectory had a greater relative risk of being prepubertal compared with boys in the lowest BMI trajectory the relationship between body fat and timing of pubertal onset is not the same in boys as it is in girls.[11] Further studies are needed to better understand the physiological link between body fat and timing of pubertal onset in both sexes and similar results seen in Surana Vet al, Busch AS et al.[12,13]

Limitation of the study was authors did not correlate the testicular volume with hormonal levels like FSH testosterone due to financial issue.

CONCLUSION

Udaipur children had early rise of testicular volume before pubic hair clinically visible which shows that testicular volume is the first to increase with the onset of puberty. The study concluded that testicular volume assessment by Prader Orchidometer is easy and reliable and accurate method in community. Testicular volume adds more objectivity in SMR detection and helps to differentiate early genital maturation than pubic hair.

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