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A new perspective on penis length measurement in children: How healthy are the results obtained with the current techniques?

Osman Akyüz 🆔

Department of Urology, School of Medicine, Atlas University, İstanbul, Turkey

Correspondence
Osman Akyüz, Department of Urology, School of Medicine, Biruni University, Özel Medicine Hospital, Hoca Ahmet Yesevi Cad. No. 149 Güneşli, Bagcılar, İstanbul.
Email:akyuzosman@hotmail.com

Abstract

In order to detect abnormalities in the size of the penis, firstly, the penis length must be measured correctly. Controversies about the best technique on to be used to measure the length of the penis still persist. The hypothesis of this study is to show that penile length in children is longer than measured under normal examination conditions. A total of 155 children who applied to our institution for circumcision whose stretched penis length (SPL) measurements were performed were included in the study. The distance from the pubic bone to the tip of the glans penis, which was maximally stretched, was measured. Under normal examination conditions (SPL 1), under general anaesthesia (SPL 2) and after skin/ subcutaneous tissues were released during circumcision (SPL 3). The mean age of the patients was 4.20 ± 2.66 years. Mean SPLs were measured as 5.48 ± 1.03 and 5.96 ± 1.01 and 6.54 ± 1.01 cm in SPL 1, SPL 2 and SPL 3 respectively. The amount of increase between penis length measurements was statistically significant ($p = .001$). In all cases (100%), penis length measurements in SPL 3 were longer relative to SPL 1 and SPL 2.

KEYWORDS
child, measures, nomograms, penis

1 | INTRODUCTION

Early recognition of abnormalities in penile size is important both medically and psychologically (Wiygul & Palmer, 2011). Penile problems such as micropenis may be an early indicator of a problem in the hypothalamic or pituitary axis, and may negatively affect the psychology of children during their development process (Reilly & Woodhouse, 1989). In order to detect abnormalities in the size of the penis, firstly, the penis length must be measured correctly. In order to evaluate whether the measurement results obtained are normal or not, it is important to know the current reference values of the penis size.

Controversies about the best technique on to be used to measure the length of the penis still persist, and different techniques have been used (Habous et al., 2018). The length of the penis has been measured from pubopenile skin junction, or from the pubic bone to the tip of the glans penis (Dillon et al., 2008). Measurements have been made on flaccid, stretched or erect penis. It has been shown that stretched penis length (SPL) is the most consistent measure of penis length and is closely related to erect penis length. Therefore, it has been reported that the most appropriate method is to measure the length of penis by stretching the flaccid penis, and measuring the distance from the suprapubic skin or pubic bone to the tip of the glans penis (Schonfeld, 1943). Measurement of penis length may be influenced by many internal and external factors. The amount of pubic adipose tissue, the anatomical features of the penis, especially the compliance of the child during the examination, the person performing the measurement and the technique used are among these factors (Habous et al., 2018). It is important to eliminate these factors as much as

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possible in terms of preventing unnecessary tests and treatments due to erroneous penis length measurements.

Studies in the literature are based on measurements made under normal examination conditions (physical examination performed at the urology outpatient clinic). In particular, the restlessness of children and their reaction to the stretching of the penis may lead to incorrect measurements. In this study, after measuring the stretched penile length (SPL) in the examination room, SPL measurements were repeated in paediatric patients who received general anaesthesia for circumcision and away from any stress. It was aimed to determine whether there was a significant difference between the SPLs measured under normal examination conditions (SPL 1), before starting circumcision under general anaesthesia (SPL2) and after skin/subcutaneous tissues were released during circumcision (SPL 3). Our study is the first study in the literature to investigate the size of the penis under general anaesthesia in children, and especially after the skin/ subcutaneous tissues are released.

2 | MATERIALS AND METHODS

A total of 160 children, aged between 0.5 and 7.5 years (mean: 4.1 ± 1.4 years), who applied to our hospital for circumcision between April 2019 and January 2020, were included in the study. Patients with congenital anomalies such as hypospadias ($n = 1$), penile curvature ($n = 3$) and bleeding diathesis such as haemophilia ($n = 1$) were excluded from the study. Apart from these, 155 circumcised patients were included in the study.

The SPL measurements of all patients were performed by the same urologist to avoid any interobserver differences that may arise. Circumcisions were performed under general anaesthesia by the same urologist by applying the guillotine method (Thermo-Med TM 802B device; Thermo Medikal; Abdulwahab-Ahmed & Mungadi, 2013). SPL 1 was measured at room temperature with the children in supine position, and in the presence of their families. The penis length was measured with a wooden ruler with 1-millimetre marks. After the adipose tissue was suppressed, the distance from the pubic bone to the tip of the glans penis, which

was maximally stretched, was measured (Figure 1a). The length of the foreskin was not included in the measurement. SPL 2 was performed in the same way before starting circumcision under general anaesthesia in the operating room on the day of the operation (Figure 1b). SPL 3, on the other hand, was performed during circumcision after the skin and subcutaneous tissues were released (Figure 1c). A significant difference (if any) between the measurements was investigated. All measurements were made by the same urologist using the same ruler. Again, the patients were stratified according to age groups and the difference between the measurements was evaluated. At the same time, the age, height and weight of the patients were recorded. Body mass index (BMI) was calculated as the ratio of weight in kilograms to the square of height in metres (kg/m^2). In our study, mean $\pm$ 2.5 *SD*s were used to determine the penile length so as to define the limit values for micropenis and macropenis.

2.1 | Statistical analysis

The normality of distribution of continuous variables was tested by Shapiro–Wilk test. Freidman test was used to compare 3 dependent measurements for non-normal data, and Dunn multiple comparison tests were used to compare non-normal data across three time points. Spearman rank correlation analysis was use to investigate relationship between two numerical variables. Statistical analysis was performed with SPSS for Windows version 24.0, and a $p < .05$ was accepted as statistically significant. This research was carried out in accordance with criteria of the World Medical Association's Declaration of Helsinki Ethical Principles for Medical Research Involving Human Subjects and ethics committee approval was obtained from our institution (register no: 2019/15-30).

3 | RESULTS

The mean age of the patients was 4.20 ± 2.66 years (0.5–7.5 years). While the mean height, weight and BMI values of the patients
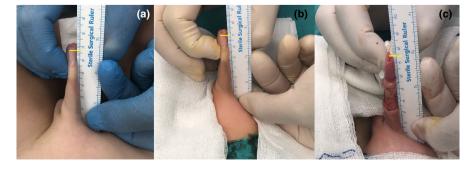

FIGURE 1 SPL 1 (a), SPL2 (b) and SPL 3 (c) measurements of the same patient. The penis length was measured as 6.6 cm in SPL1, while its length reached to 7.5 cm in SPL 3. SPL 1, stretched penile length in the examination room; SPL 2, stretched penile length under general anaesthesia; SPL 3, stretched penile length during circumcision

TABLE 1 Patient characteristics

	Mean ± *SD*
Age (years)	4.20 ± 2.66
Height (cm)	103.1 ± 24.90
Weight (kg)	18.42 ± 8,50
Body mass index (kg/m^2)	16.57 ± 2.06
SPL 1 (cm)	5.48 ± 1.03
SPL 2 (cm)	5.96 ± 1.01
SPL 3 (cm)	6.54 ± 1.01

Abbreviations: SPL 1, stretched penile length in the examination room; SPL 2, stretched penile length under general anaesthesia; SPL 3, stretched penile length during circumcision.

TABLE 2 Differences in penile length between SPL 1, SPL 2 and SPL 3 measurements

Changing state	Increase in length, cm	*p* Value
From SPL 1 to SPL 3	1.05 ± 0.58	.001
From SPL 1 to SPL 2	0.48 ± 0.54	.001
From SPL 2 to SPL 3	0.57 ± 0.29	.001

Abbreviations: SPL 1, Stretched penile length in the examination room; SPL 2, stretched penile length under general anaesthesia; SPL 3, stretched penile length during circumcision.

were 103.1 ± 24.92 cm,18.42 ± 8.50 kg and 16.57 ± 2.06 kg/m^2 respectively. Mean penis lengths were found to be 5.48 ± 1.03 and 5.96 ± 1.01 and 6.54 ± 1.01 cm measurements in SPL 1, SPL 2 and SPL 3 respectively (Table 1).

When measurements of SPL 1 and SPL 2 were compared, the mean penis length in SPL 2 was 0.48 ± 0.54 cm longer. Similarly, when SPL 1 and SPL 3 measurements were compared, the mean penis length was 1.05 ± 0.58 cm longer in SPL 3. When SPL 2 and SPL 3 measurements were compared, the mean penis length was 0.57 ± 0.29 cm longer in SPL 3 (Table 2). The differences detected in all three groups were found to be statistically significant ($p = .001$). Considering all measurements (100%), penis lengths in SPL 3 were longer than SPL 1 and SPL 2. In 143 (92.26%) cases, penis lengths in SPL 2 were measured as longer than SPL 1, while in 12 (7.74%) cases, SPL 1 was longer than SPL 2.

After the patients were stratified according to age groups, the measurements were re-examined. There was a significant difference between SPL 1, SPL 2 and SPL 3 in the <1, 5–6, 6–7 and 7–8 age groups. ($p = .001$). No significant difference was observed between the SPL 1 and SPL 2 measurements in the 1–2, 2–3, 3–4 and 4–5 age groups. The difference between other measurements was significant. According to Dunn's multiple comparison test, it was seen that there was a significant increase in all measurements with increasing age (Table 3).

A strong positive correlation was found between body height and SPL 1, SPL 2 and SPL 3 measurements ($r = .703$, $p = .001$; $r = .728$, $p = .001$; $r = .758$, $p = .001$ respectively). Similarly, there was a strong

TABLE 3 Relationship between SPL 1, SPL 2 and SPL3 measurements by age groups

Age (years)	*n*	Measurement	*p* Value
<1	31	SPL 1–SPL 2	.001*
		SPL 1–SPL 3	.001*
		SPL 2–SPL 3	.001*
1–2	13	SPL 1–SPL 2	.141
		SPL 1–SPL 3	.001*
		SPL 2–SPL 3	.003*
2–3	15	SPL 1–SPL 2	.068
		SPL 1–SPL 3	.001*
		SPL 2–SPL 3	.003*
3–4	9	SPL 1–SPL 2	.077
		SPL 1–SPL 3	.001*
		SPL 2–SPL 3	.034*
4–5	11	SPL 1–SPL 2	.394
		SPL 1–SPL 3	.001*
		SPL 2–SPL 3	.006*
5–6	13	SPL 1–SPL 2	.050*
		SPL 1–SPL 3	.001*
		SPL 2–SPL 3	.011*
6–7	17	SPL 1–SPL 2	.026*
		SPL 1–SPL 3	.001*
		SPL 2–SPL 3	.001*
7–8	46	SPL 1–SPL 2	.016*
		SPL 1–SPL 3	.001*
		SPL 2–SPL 3	.001*

Abbreviations: SPL 1, stretched penile length in the examination room; SPL 2, stretched penile length under general anaesthesia; SPL 3, stretched penile length during circumcision. *: Statistically significant.

positive correlation between body weight and all three measurements ($r = .703$, $p = .001$; $r = .716$, $p = .001$; $r = .758$, $p = .001$ respectively). A significant correlation did not exist between BMI and SPL1 ($r = -.156$, $p = .052$), while a weakly significant correlation was found between BMI and SPL 2 and SPL 3 measurements ($r = -.210$, $p = .009$; $r = -.185$, $p = .021$; Table 3). In our study, none of the patients were diagnosed with micropenis or macropenis according to the mean stretched penis limit values.

4 | DISCUSSION

Penis size has been associated with sexual power, strength and courage in societies throughout history and has been accepted as a symbol of masculinity. It has been reported that abnormalities related to penile length can lead to serious psychological problems (Veale et al., 2014). Although penis lengths are within normal limits, many people consult a doctor because they consider that their penises are small in size. Especially in obese children, conditions such as an

embedded penis are a concern for their families and sometimes for children. However, most of these patients have been shown to have penis sizes within normal limits (Wylie & Eardley, 2007). Therefore, it is important to measure the penis length correctly in order to detect abnormalities in the size of the penis. However, it has been reported that there is no consensus in the literature about the method preferred for the evaluation of the penis size, and also, there is no standard measurement method (Greenstein et al., 2020).

Different measurement techniques have been described in the literature on penis length. Measurements were performed on the flaccid, stretched or erect penises. Measurements were made from the pubic bone or from the penopubic skin junction to the tip of the glans penis (Habous et al., 2018). The first study on the length of the penis was done by Loeb while the penis was in the flaccid state (Dillon et al., 2008). Schonfeld and Beebe reported that the most consistent measurements of penis length were performed on the fully stretched penis. They reported that the SPL was almost the same as the actual length of the penis and is therefore acceptable as a suitable measurement (Schonfeld & Beebe, 1942). In another study, Schonfeld reported that the length of the relaxed flaccid penis varies greatly due to environmental factors and suprapubic obesity, and it is necessary to measure the length of fully stretched penis to make a healthy measurement (Schonfeld, 1943).

Another discussion topic is how much force should be applied during stretching when measuring SPL. An engineering model has been developed to analyse the differences between the results obtained during stretching and erection and to determine the optimal tensile force values to be applied. In their engineering analysis, Chen et al. reported that a minimum tensile force of approximately 450 g should be applied to the penis to reach the potential erection length. It was emphasised in the same study that the stretching forces exerted in the clinical setting by the urologist were statistically significantly lower (Chen et al., 2000). However, they did not clarify how the urologist would determine the application of 450 g of force when taking measurements in the examination room.

Studies in the literature are based on measurements made under normal examination conditions. In particular, the restlessness of children and their reaction to the stretching of the penis can lead to incorrect measurements. In this study, penis lengths were measured priorly in the examination environment; then, SPL measurements were repeated during circumcision under general anaesthesia where the patient was fully compliant. In our study, longer SPL 3 measurements were obtained than SPL 1 and SPL 2. Again, SPL 2 measurement results were determined to be significantly longer than SPL 1. Noncompliance of the child during examination makes it difficult to measure excess foreskin and pubic adipose tissue in uncircumcised children. Therefore, noncompliance of the child may cause penis size to be measured shorter or longer than its normal size. The significant difference between SPL 1, SPL 2 and SPL 3 measured by the same examiner in favour of SPL 3 may result from these inconveniences in the examination

TABLE 4 Evaluation of the correlation between SPL 1, SPL 2 and SPL 3 measurements with age, height, weight and BMI

	SPL 1	SPL 2	SPL 3
Height (cm)			
r	.703**	.728**	.758**
p	.001	.001	.001
Weight (kg)			
r	.703**	.716**	.758**
p	.001	.001	.001
Body mass index (kg/m^2)			
r	−.156	−.210**	−.185*
p	.052	.009	.021

Abbreviations: r, Spearman rank correlation coefficient; SPL 1, stretched penile length in the examination room; SPL 2, stretched penile length under general anaesthesia; SPL 3, stretched penile length during circumcision.
*Significant at .5 level.
**Significant at .01 level.

room. Contrary to expected, 12 (7.74%) patients may be found to have SPL 1 values longer than SPL 2 for the same reasons. However, none of the SPL 2 measurements performed under general anaesthesia after elimination of restlessness and noncompliance were determined to be longer than SPL 3 performed under general anaesthesia. The fact that the measurement of increased penile length in SPL 3 relative to SPL 2 shows that the penis becomes more mobile after the skin/subcutaneous tissues are released during circumcision which also affects the measurement results (Table 4).

Tunica albuginea consists of collagen and elastic fibres. The elasticity of collagen fibres is limited. Therefore, it is the amount of elastin fibres that determine the SPL (Udelson et al., 1998). In our study, we found a difference between SPL 1, SPL 2 and SPL 3 with age. This may be due to the fact that older children show more restlessness and affect the measurement result more. Or it may be due to changes in elastin content with age. However, it is not ethically possible to show this situation.

Though not statistically significant, the length of the flaccid penis has been reported to be associated with BMI. It has been noted that in children with greater BMI, the prepubic adipose tissue will be thicker, and therefore, the length of the flaccid penile will be underestimated (Habous et al., 2018). In some studies, a strong correlation has been demonstrated between somatometric parameters such as height, weight and BMI with penile length, while in some other studies, a clinically insignificant weak correlation was revealed (Camurdan et al., 2007; Aslan et al., 2011). In our study, a strong positive correlation was found between height and weight and SPL 1, SPL 2 and SPL 3 measurements. In our study, diagnosis of micropenis in any patient made during SPL 1 measurement was also confirmed after SPL 2 and SPL 3 measurements. However, the significant difference arising between the measurements indicates that such cases may be encountered.

5 | CONCLUSION

This study showed that penile lengths measured in SPL3 were statistically significantly longer relative to measurements performed during SPL 1. Since it is not possible to measure SPL 3 in daily practice, it should be taken into consideration that the actual penis length is slightly longer than the measured SPL 1 especially in cases where micropenis is considered. Larger case studies are needed to standardise and generate nomograms using SPL 3 measurements.

CONFLICTS OF INTEREST
There are no conflicts of interest.

DATA AVAILABILITY STATEMENT
All data underlying the findings are available at the Internet address 'https://www.atlas.edu.tr/'.

ORCID
Osman Akyüz https://orcid.org/0000-0002-1402-7664

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