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The Impact of Weight and Circumcision on Penile Measurements and Micropenis Evaluation in Pediatric Patients

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What is known on this subject?

Penile measurements in pediatric patients are highly sensitive to external clinical factors, and current evaluation methods can yield inconsistent outcomes depending on individual physical characteristics. Circumcision status and body weight percentile are known to substantially influence both flaccid and stretched penile length (SPL) measurements, often complicating clinical assessments. Confounding factors—such as increased suprapubic fat or post-operative tissue changes—frequently create measurement-related variability that can obscure true anatomical dimensions, directly impacting the accuracy of micropenis screening and pediatric clinical decision-making.

What this study adds?

This study of 540 patients demonstrates a paradoxical decrease in SPL following circumcision in overweight children, highlighting measurement variability over true anatomical change. The findings emphasize that incorporating weight percentile and circumcision status into normative reference charts is necessary for refining pediatric micropenis diagnosis.

ABSTRACT

Objective: Penile measurements are critical in the evaluation of micropenis, yet the potential effects of circumcision and higher body weight percentiles remain underexplored. This study aimed to assess how circumcision status and weight percentiles (specifically comparing $<75^{th}$ and $\geq 75^{th}$ percentiles) influence penile length measurements and glans diameter (GD) in children aged 0-10 years.

Material and Methods: This retrospective study included 540 boys who underwent circumcision between 2022 and 2024. Age, weight, and weight percentile were recorded along with penile measurements. Baseline (flaccid) penile length (BPL) and stretched penile length (SPL) were measured before circumcision; BPL, SPL, and GD were reassessed postoperatively. Patients were categorized as $<75^{th}$ or $\geq 75^{th}$ percentile for weight. Comparative and correlational analyses were conducted to evaluate associations between weight status and penile measurements.

Results: In infants, SPL was significantly lower in children in the $\geq 75^{th}$ percentile group compared to those in the $<75^{th}$ percentile group. Across all age groups, BPL was significantly lower in children with higher weight percentiles. GD was larger only among infants in the $\geq 75^{th}$ percentile group. While SPL generally increased following circumcision, a paradoxical decrease was noted in children with higher weight percentiles ($\geq 75^{th}$ percentile), likely reflecting differences in measurement conditions rather than true anatomical shortening.

Conclusion: Circumcision status and weight percentile may significantly influence penile measurements among children. Current normative data may not fully represent circumcised children and those with higher weight percentiles, potentially affecting clinical interpretation. These findings should be interpreted as reflecting measurement-related variability rather than true anatomical changes in penile length. Updated population-specific reference standards incorporating circumcision status and body weight percentiles may improve diagnostic accuracy and clinical decision-making.

Keywords: Micropenis, circumcision, body weight percentiles, penile length measurements, children, concealed penis

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Introduction

Circumcision has been practiced mostly on boys since ancient times for religious, cultural, and personal reasons. Almost 40% of adult men worldwide are circumcised, with approximately 80% in the United States and 99% in Islamic countries such as Türkiye (1). Male circumcision involves excision of the prepuce covering the glans. Despite its prevalence, few studies have examined the impact of circumcision on penile measurements, particularly in children. The penile length and glans diameter (GD) are key parameters for evaluating normal penile development. Understanding how these measurements change before and after circumcision is crucial for assessing the effects of the procedure, identifying potential complications (such as an inconspicuous penis or other penile disorders), and evaluating a diagnosis of micropenis.

A micropenis is defined as a penis size that is significantly shorter due to hormonal or genetic reasons (2). Specifically, a penis length below 2.5 SDs is generally accepted as the criterion for diagnosing a micropenis. Being below 2.5 SDs corresponds to falling below the measurements of 99.4% of the normal population. The evaluations also considered pubertal stage and age. The diagnosis of micropenis is established by physical examination, the most important component of which is measurement of penile length. During measurement of penile length, the penis was stretched maximally toward the pubis, and the stretched penile length (SPL) was measured. These evaluations and diagnoses were based on overall averages.

According to the 2022 World Obesity Atlas, more than 100 million children aged 5-9 and over 150 million children aged 10-19 years will be affected by obesity worldwide by 2030 (3). In pediatric clinical practice, analyzing how variations in body weight percentiles interact with anatomical assessments is essential, as increased suprapubic fat pad thickness can potentially confound physical examination findings, including penile measurements (4,5).

The primary objective of this study was to evaluate the combined impact of circumcision status and body weight percentiles (<75th vs. ≥75th percentile) on penile length measurements and GD during micropenis assessment in children aged 0-10 years.

Although previous literature has occasionally addressed penile sizes before and after surgery, the specific interaction between circumcision status and body weight percentiles has received limited attention in the pediatric literature.

By comparing these measurements, this study seeks to provide a better understanding of the effects of circumcision and weight status on penile assessment and to contribute to the existing knowledge on pediatric urology.

Material and Methods

Study Design

This retrospective study included data from 540 patients aged 0-10 years who underwent circumcision at the Pediatric Surgery Department of the Ordu University Faculty of Medicine Training and Research Hospital between 2022 and 2024. In our clinic, penile measurements are performed routinely and in a standardized manner as part of the preoperative and intraoperative clinical assessment under anesthesia for all children undergoing urological procedures, and these data are systematically recorded in patient charts.

In this study, participants were divided into five main age groups: infants (0-2 years), 3-4-year-olds, 5-6-year-olds, 7-8-year-olds, and 9-10-year-olds. The patients' weight percentiles were evaluated using the Centers for Disease Control and Prevention growth charts and the World Health Organization weight-for-age standards for boys. Patients with weight above the 75th percentile were categorized separately (6,7). This classification aimed to enable a comparison between children in the higher weight percentile group (≥75th percentile) and those in the lower weight percentile group (<75th percentile), to test the study hypothesis.

Ethical approval for this study was obtained from the Ordu University Non-Interventional Scientific Research Ethics Committee on September 13, 2024 (approval number: 2024/116). Because this study utilizes a retrospective design based on historical patient records and contains absolutely no patient-identifying personal data, the requirement for written informed consent was evaluated and waived by the institutional review board.

Inclusion and Exclusion Criteria

Inclusion criteria: Male children aged 0-10 years who underwent circumcision at our clinic and had penile measurements recorded both before and after the procedure (while under anesthesia) were included in the study.

Exclusion criteria: Children were excluded if they had congenital penile anomalies such as hypospadias, penile chordee, or buried penis; acquired penile deformities resulting from circumcision complications; chronic diseases affecting physical development (e.g., hemiplegia, Grade 3-5 cerebral palsy, severe congenital heart defects); or scrotal pathologies causing swelling, such as hydrocele.

Data Collection

Demographic data, including age, weight, weight percentile, and penile measurements, were recorded for each patient. Penile measurements included:

Before circumcision (under anesthesia): Baseline (flaccid) penile length (BPL) and SPL.

After circumcision (under anesthesia): BPL, SPL, and GD.

All measurements were performed under anesthesia by the same two surgeons using a standardized technique to minimize inter-observer variability. To achieve strict standardization, all measurements were conducted in an operating room maintained at a constant ambient temperature (22 °C), with the patient in a supine position under general anesthesia, ensuring total muscle relaxation. Penile length was measured dorsally at a 90-degree angle using a single-use, rigid cardboard ruler calibrated in millimeters, which was chosen to ensure strict cross-infection control for each patient. For the SPL measurement, the surgeon firmly compressed the suprapubic adipose tissue vertically at the base of the penis until the rigid edge of the ruler directly abutted the underlying pubic bone, fully displacing the fat pad. Simultaneously, the glans penis was grasped and stretched dorsally along its longitudinal axis with a steady, uniform force until definitive physical tissue resistance (maximum non-elastic extension) was reached; the distance to the tip of the glans was then recorded. GD was measured at the coronal sulcus after circumcision (Figure 1).

Statistical Analysis

Statistical analyses were performed using SPSS version 25.0. Descriptive analyses were presented using the mean, standard deviation (SD), median, and min-max values. Non-parametric variables were compared between two groups using the Mann-Whitney U test. Changes in measured values between groups were evaluated using repeated measures analysis. p values below 0.05 were considered statistically significant.

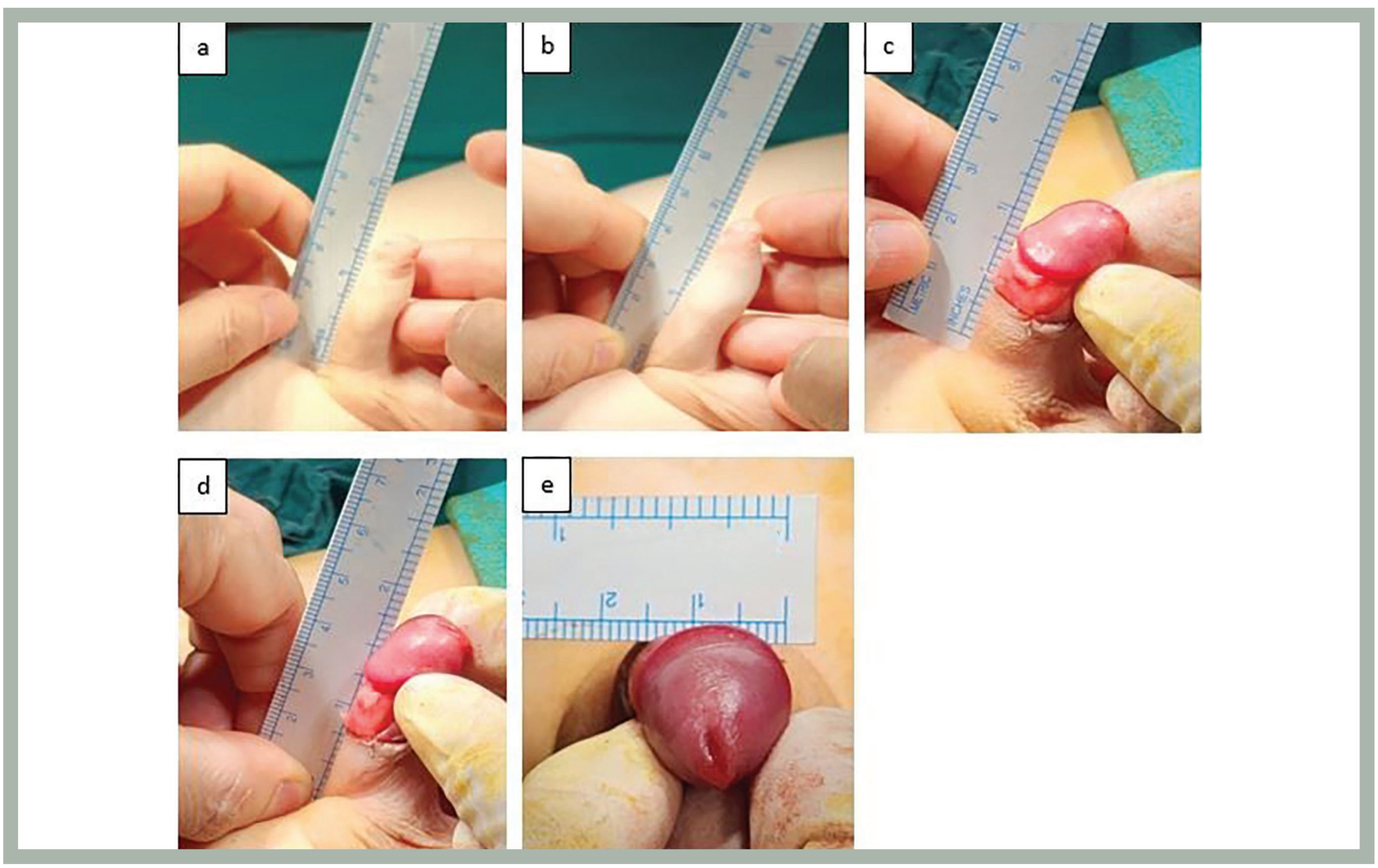

Figure 1. The measurements taken sequentially on the same patient have been photographed. a) Before circumcision, under anesthesia BPL. b) Before circumcision, under anesthesia SPL. c) After circumcision, under anesthesia BPL. d) After circumcision, under anesthesia SPL. e) Glans diameter measurement

BPL: Baseline (flaccid) penile length, SPL: Stretched penile length

Results

Patients Demographics

A total of 540 patients were included in the study. The demographic characteristics of the patients are detailed in the table below. The age ranges from 17 to 117 months (minimum-maximum: 5-120 months). Weight percentile values were categorized as <75th percentile (P) and <75th percentile (Figure 2). Specifically, in the 3-4-year age group, circumcision in Ordu University Training and Research Hospital is not typically performed on children aged 3-5 years due to the psychosexual development phase. Therefore, the sample size for this group is insufficient (Table 1).

Penile Measurements

Baseline (Flaccid) Penile Length

The change in BPL was compared separately for each age group between those below the <75th percentile (<75 P) and those at or above the <75th percentile (≥75 P). In the infant group, the BPL value decreased more in those with ≥75 P compared to those with <75 P. No significant change was found in other age groups. When looking at the change in BPL within the groups, a significant decrease was observed in the 5-6 and 7-8 age groups for those with <75 P, and in the infant, 5-6, and 7-8 age groups for those with ≥75 P (Table 2).

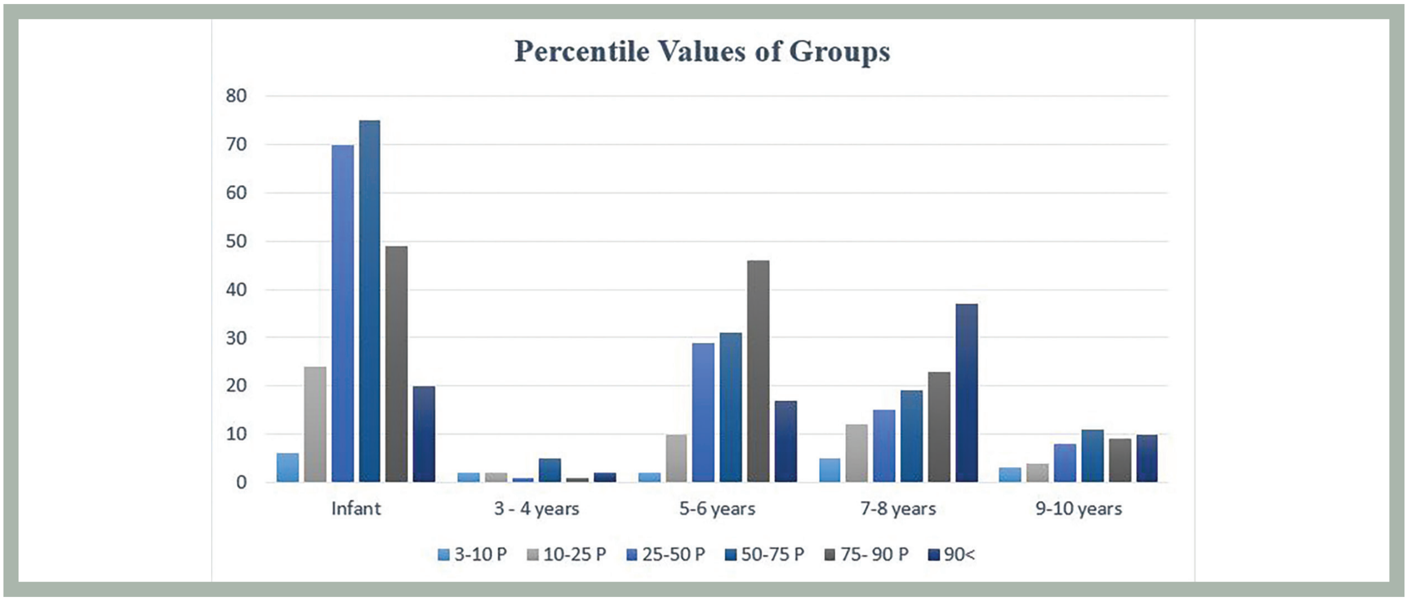

Figure 2. Weight percentile values of groups

Table 1. Patient demographics and penile measurements

<75th P	n	Age (months)	Weight (kg)	BPL (mm)	SPL (mm)	GL (mm)	PC-BPL (mm)	PC-SPL (mm)
Infant	161	18.84	11.16	27.71	38.34	16.19	27.41	38.31
3-4	9	42.67	14.28	33.00	42.67	17.89	31.33	43.00
5-6	64	68.34	19.31	35.70	44.52	18.17	32.92	43.14
7-8	52	89.42	23.20	35.75	44.85	19.02	32.69	42.50
9-10	19	112.74	28.24	36.21	46.32	19.32	33.89	44.84
≥75th P								
Infant	83	17.64	13.51	30.75	42.78	19.10	28.52	41.53
3-4	7	41.14	18.14	27.00	37.00	17.86	29.00	34.14
5-6	71	71.49	25.10	31.41	43.25	18.46	30.07	41.80
7-8	58	90.31	33.34	32.20	43.75	19.15	29.85	42.51
9-10	16	117.38	41.69	32.56	46.00	18.75	29.75	44.81

BPL: Baseline (flaccid) penile length, SPL: Stretched penile length, GL: Glans Lenght, PC: Post-circumcision

Stretched Penile Length

For each age group, change in SPL was compared between those below the <75th percentile and those at or above the <75th percentile. In the infant group, the SPL value decreased more in those with ≥75 P compared to those with <75 P. The decrease in SPL value by percentile in other age groups was not found to be significant. When looking at the change in SPL within the groups, a significant decrease was observed in the 5-6 and 7-8 age groups for those with <75 P, and in the infant and 7-8 age groups for those with ≥75 P (Table 3).

Table 2. The change in BPL was compared separately for each age group between <75 P and ≥75 P

		<75 P		≥75 P		
		Mean ± SD (mm)	**Median (min-max) (mm)**	**Mean ± SD (mm)**	**Median (min-max) (mm)**	**p^1**
Infant	BPL	27.71±5.18	27 (15-50)	30.75±7.08	30 (20-47)	**0.002**
	PC-BPL	27.41±5.33	26 (15-45)	28.52±6.35	28 (10-50)	
p^2		0.398		**0.001**		
3-4	BPL	33±6.46	33 (22-40)	27±6.81	27 (20-35)	0.177
	PC-BPL	31.33±6.44	30 (22-40)	29±5.66	32 (20-35)	
p^2		0.196		0.610		
5-6	BPL	35.7±6.63	35 (20-50)	31.41±6.61	30 (20-47)	0.113
	PC-BPL	32.92±6.6	32.5 (20-50)	30.07±7.03	30 (18-50)	
p^2		**<0.001**		**0.037**		
7-8	BPL	35.75±6.75	35 (25-50)	32.2±7.93	30 (17-55)	0.515
	PC-BPL	32.69±5.36	32 (23-45)	29.85±6.33	30 (20-53)	
p^2		**0.001**		**0.003**		
9-10	BPL	36.21±5.44	35 (30-50)	32.56±6.43	31 (25-45)	0.792
	PC-BPL	33.89±5.1	32 (25-42)	29.75±7.7	30 (20-50)	
p^2		0.115		0.051		

[1]Repeated measures analysis, [2]Wilcoxon test. SD: Standard deviation, BPL: Baseline (flaccid) penile length, PC: Post-circumcision, min-max: Minimum-maximum

Table 3. The change in SPL was compared separately for each age group between <75 P and ≥75 P

		<75 P		≥75 P		
		Mean ± SD (mm)	**Median (min-max) (mm)**	**Mean ± SD (mm)**	**Median (min-max) (mm)**	**p**
Infant	SPL	38.34±6.4	40 (21-60)	42.78±8.59	45 (26-65)	**0.047**
	PC-SPL	38.31±5.87	37 (24-53)	41.53±6.94	40 (28-60)	
p^2		0.695		**0.037**		
3-4	SPL	42.67±5.52	43 (35-50)	37±6.08	40 (28-45)	0.113
	PC-SPL	43±6.12	44 (35-55)	34.14±9.15	37 (15-40)	
p^2		0.892		0.144		
5-6	SPL	44.52±6.44	45 (33-60)	43.25±7.43	42 (30-60)	0.936
	PC-SPL	43.14±6.13	43,5 (32-55)	41.8±6.73	41 (25-60)	
p^2		**0.022**		0.085		
7-8	SPL	44.85±7.99	45 (30-60)	43.75±7.06	45 (25-60)	0.257
	PC-SPL	42.5±6.34	42 (30-60)	42.51±6.77	42 (28-65)	
p^2		**0.008**		**0.043**		
9-10	SPL	46.32±8.71	45 (35-65)	46±11.37	45.5 (30-80)	0.884
	PC-SPL	44.84±7.46	45 (35-65)	44.81±12.68	45 (25-85)	
p^2		0.409		0.202		

[1]Repeated measures analysis, [2]Wilcoxon test. SD: Standard deviation, SPL: Stretched penile length, PC: Post-circumcision, min-max: Minimum-maximum

In the infant group, the average SPL value before and after circumcision post-circumcision (PC-SPL) varied by percentile, with a more pronounced postoperative decrease observed in the higher-percentile group. When micropenis was evaluated using individual patient data, it was detected in 5.6% (n=12) of the infant group before circumcision. This rate decreased to 3% (n=7) after circumcision; however, when evaluated individually, the presence or absence of micropenis differed in 13 patients between pre- and PC assessments.

In the 5–6-year age group, micropenis was detected in 13% (n=18) of patients before circumcision and in 14% (n=19) after circumcision. When these data were examined individually, 15 patients showed a change in the presence or absence of micropenis before vs. after circumcision.

Glans Diameter

As a result of comparing GD values between percentile groups for each age group separately, it was observed that in the infant group, those with ≥75 P had higher GD values compared to those with < 75P. In other groups, no significant difference in GD measurements was found between percentiles above and below the 75th (Table 4).

As shown in Table 4, the standard mean values among children below the 75th percentile increase proportionally with age. However, age-independent changes have been observed in children above the 75th percentile, unlike in those below the 75th percentile.

Discussion

Penile shortening is a condition that may raise concerns among both parents and children, leading to significant psychosocial consequences, including impaired self-confidence and disruption of sexual identity development. Early diagnosis and the continuous updating of treatment and follow-up protocols are critical in the management of micropenis. It is recommended that follow-up, extending from the neonatal period through adolescence, be conducted via a multidisciplinary approach involving pediatric urology, pediatric endocrinology, and pediatric psychiatry (6).

Micropenis is defined, based on normative data adjusted for ethnicity and geographic region, as a SPL below -2.5 SDs. According to national standards, Cinaz et al. (7) reported a mean SPL of 5.4 cm for the infant group in Türkiye, with a corresponding -2.5 SD threshold of 3.8 cm. In contrast, the widely referenced study by Custer and Rau (9) reported a mean SPL of 4.7 cm for the infant group, with the -2.5 SD value at 2.6 cm (8)

In our study, the mean SPL in the ≥75th percentile weight group was 4.2 cm (minimum 2.6 cm), while in the <75th percentile group, it was 3.8 cm (minimum 2.1 cm) for infants (Table 5). Similarly, in the 5-6-year age group, which included the second-largest number of patients, SPL measurements obtained before circumcision were below the micropenis threshold according to both reference standards.

Table 4. GD values between percentile groups

GD	<75 P		≥75 P		p
	Mean ± SD	**Median (min-max)**	**Mean ± SD**	**Median (min-max)**	
Infant	16.19±1.82	16 (12-20)	19.1±2.47	20 (15-26)	**<0.001**
3-4	17.89±2.52	18 (13-20)	17.86±2.12	17 (15-20)	0.824
5-6	18.17±2.39	18 (10-25)	18.46±2.43	18 (13-23)	0.426
7-8	19.02±2.11	20 (15-25)	19.15±3.48	19 (12-32)	0.909
9-10	19.32±3.16	20 (15-27)	18.75±6.09	17.5 (15-30)	0.652

Mann-Whitney U test. GD: Glans diameter, SD: Standard deviation, min-max: Minimum-maximum

Table 5. SPL values of the infant and 5-6 age groups: standard references and measurements from this study

	Age groups	Mean (cm)	-2.5 SD (cm)
Custer and Rau (9)	Infant	4.7	2.6
Cinaz et al. (7)	Infant	5.4	3.8
This study (PC-SPL)	**Infant (<75 P≥75 P)**	**3.8-4.1**	**2.4-2.8**
Custer and Rau (9)	5-6	6.0	3.8
Cinaz et al. (7)	5-6	6.3	4.45
This study (PC-SPL)	**5-6 (<75 P≥75 P)**	**4.3-4.1**	**3.2-2.5**

PC-SPL: Post-circumcision-stretched penile length, SD: Standard deviation

When infants were individually assessed, micropenis was identified in 5.6% prior to circumcision, decreasing to 3% postoperatively. In the 5-6-year age group, the prevalence of micropenis slightly increased from 13% preoperatively to 14% postoperatively. These findings suggest that both body weight percentiles and circumcision status may significantly influence the clinical evaluation and diagnosis of micropenis. However, circumcision does not alter the anatomical length of the penile shaft; the observed differences most likely reflect measurement-related variability, such as suprapubic fat compression, traction applied during SPL measurement, and absence of the prepuce as a reference landmark after circumcision. Therefore, the detected variations should be interpreted as measurement-related changes rather than true morphological alterations.

Akyüz (10) were among the first to investigate differences in SPL between circumcised and uncircumcised children, reporting significantly higher SPL values in circumcised patients. Their findings demonstrated that penile length measurements taken after circumcision were significantly longer than those taken before the procedure (10). These results support the findings of the current study, indicating that circumcision can influence penile measurements without affecting anatomical penile length.

Because the diagnosis of micropenis is based exclusively on SPL measurements, methodological differences in SPL measurements before and after circumcision may lead to false-positive or false-negative diagnoses. Clinicians should therefore interpret SPL values cautiously, particularly in recently circumcised patients and when evaluating micropenis based solely on SPL measurements.

With growing concerns about variations in pediatric body weight and their effects on general health, understanding the relationship between weight percentiles and penile dimensions may provide valuable insights for clinical assessment and surgical planning. Such knowledge is essential for improving the accuracy of diagnoses and optimizing patient outcomes.

A study by Mancini et al. (11) found that penile length in children with higher weight percentiles was approximately 10% shorter compared to children with normal weight. The authors also proposed a modified technique to enhance the accuracy of penile measurements in both normal-weight and higher-weight boys. Similarly, a study by Lee et al. (12) reported that body mass index (BMI) had a measurable impact on penile size assessments, with children in the normal BMI range having significantly longer BPL and SPL values than their higher-weight counterparts (12).

In our study, penile measurements in children with higher weight percentiles (≥75th percentile) were compared to those of children with normal or below-normal weight (<75th percentile). The results showed age-dependent differences: in the infant group, SPL values were significantly higher in the ≥75 P group compared to the <75 P group. However, repeated measurements in the ≥75 P group before and after circumcision revealed a significant decrease in SPL following the procedure. This reduction likely reflects technical measurement conditions and the presence of a prominent suprapubic fat pad PC, rather than an actual decrease in penile tissue length.

Conversely, in the 5-6 years age group, children in the ≥75 P group had significantly shorter SPL values than those in the <75 P group. Additionally, both percentile groups within this age range demonstrated significant reductions in SPL after circumcision. Among infants, these findings suggest that higher weight percentiles are associated with greater measured penile length. However, among children in higher percentiles, particularly in the 5-6-year group, pre-circumcision measurements may appear shorter, and the circumcision procedure may introduce further measurement-related variability that reduces the penile length measured on physical examination. Therefore, circumcision and weight percentile should be considered solely confounding factors when evaluating penile size, especially in the context of micropenis assessment, as they do not alter the underlying penile morphology.

Previous longitudinal studies have demonstrated that a proportion of children diagnosed with micropenis or constitutional small penis in the prepubertal period may reach normal penile dimensions during puberty, emphasizing the need for cautious interpretation of early diagnoses (13,14).

When evaluating glans size, GD was measured as the width rather than as the penile circumference. This measurement method is commonly used in the surgical assessment of patients with hypospadias. As expected, anthropometric measurements, such as GD, increase proportionally with age across all percentile groups. In our study, GD measurements increased proportionally with age in children below the 75th percentile (<75 P). However, in children at or above the 75th percentile (≥75 P), this pattern was not observed, and the results varied independently of age.

When subgroup analyses were performed, a statistically significant increase in GD was found only in infants in the ≥75 P group compared to those in the <75 P group. In all other age groups, the weight percentile did not appear to influence GD.

Bush et al. (15) reported that a smaller glans size is associated with a higher risk of urethroplasty complications. Based on our findings, weight percentile did not appear to influence GD in children older than two years with hypospadias. However, in the infant group, the observed proportional increase in GD among children in higher percentiles is a notable clinical finding that warrants further investigation of its anatomical permanence, and it may have a beneficial effect on surgical outcomes of procedures such as urethroplasty.

Study Limitations

This single-center, retrospective study has limited generalizability. Secondly, due to the retrospective design of our study, a formal post-hoc statistical analysis for inter-observer agreement could not be performed. Although all measurements follow a strict, deeply embedded institutional standardization protocol using identical anatomical landmarks across all urological procedures, minor variations arising during handovers or from differences in individual technique between the two senior surgeons cannot be entirely ruled out. Furthermore, using the 75^{th}-percentile weight cut-off rather than the stricter 95^{th}-percentile definition of obesity limits direct comparison with the pediatric obesity literature and constitutes another methodological limitation.

The use of manual measurement tools may have introduced minor inaccuracies; potential confounding factors, such as hormonal or genetic influences, were not assessed. Postoperative conditions such as partial penile entrapment or trapped penis, which may influence perceived penile length, were not systematically evaluated and should be considered in future prospective studies. Furthermore, utilizing the 75^{th} percentile weight cut-off rather than the standard percentile thresholds for overweight or obesity limits direct comparison with broader pediatric weight-status literature, which is another methodological limitation.

Conclusion

This study demonstrates that circumcision status and body weight percentile can substantially influence penile measurement outcomes in pediatric patients, highlighting the importance of standardized measurement techniques in clinical evaluation. Importantly, the observed PC differences most likely reflect measurement-related variability rather than true anatomical alterations. Incorporating circumcision status and weight percentile into future normative reference data may improve the accuracy of micropenis diagnosis and enhance clinical decision-making in pediatric practice.

Ethics

Ethics Committee Approval: Ethical approval for this study was obtained from the Ordu University Non-Interventional Scientific Research Ethics Committee on September 13, 2024 (approval number: 2024/116).

Informed Consent: Because this study utilizes a retrospective design based on historical patient records and contains absolutely no patient-identifying personal data, the requirement for written informed consent was evaluated and waived by the institutional review board.

Footnotes

Authorship Contributions

Surgical and Medical Practices: A.K.A., O.Y., Concept: A.K.A., Design: A.K.A., Data Collection or Processing: A.K.A., O.Y., Analysis or Interpretation: A.K.A., Literature Search: A.K.A., Writing: A.K.A., O.Y.

Conflict of Interest: No conflict of interest was declared by the authors.

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