EDITORIAL


REVIEW


MINIREVIEWS


ORIGINAL ARTICLE

Case Control Study


Retrospective Study

Observational Study


Randomized Controlled Trial


SYSTEMATIC REVIEWS


CASE REPORT

ABOUT COVER
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Microphallus early management in infancy saves adulthood sensual life: A comprehensive review

Mohammed Al-Beltagi, Nermin Kamal Saeed, Adel Salah Bediwy, Majed A Shaikh, Reem Elbeltagi

Microphallus/Micropenis is a rare condition with significant physical and psychological implications for affected individuals. This article comprehensively reviews micropenis, its etiology, epidemiology, and various treatment options. We conducted a thorough literature review to collect relevant information on micropenis and microphallus, as well as related disorders. Our primary databases

Abstract

Microphallus/Micropenis is a rare condition with significant physical and psychological implications for affected individuals. This article comprehensively reviews micropenis, its etiology, epidemiology, and various treatment options. We conducted a thorough literature review to collect relevant information on micropenis and microphallus, as well as related disorders. Our primary databases
INTRODUCTION

Micropenis, also known as microphallus, is a medical condition where the penis size is abnormally small, usually below the average for a given age group. This condition is defined when the length of the stretched penis falls below 2.5 standard deviations (SDs) beneath the mean for the age group, which may vary slightly depending on the population studied. In newborn males born full term, the average stretched penile length is 3.5 cm. Micropenis is defined when it measures less than 2 cm–2.5 cm (2.5 SDs beneath the mean) [1,2]. The term microphallus is used when there is an associated hypospadias or some degree of ambiguity. Severe forms of microphallus are considered ambiguous genitalia [3]. The presence of a well-developed scrotum and adequately sized, palpable testicles suggest a high likelihood of a normal male karyotype. However, the absence of palpable testicles and penile urethra may indicate ambiguity, requiring karyotyping and counseling for sex developmental disorders [4].

The appearance of micropenis and microphallus during infancy, adolescence, or adulthood presents significant questions about embryogenesis, hormonal signaling, and possible causes [5]. Microphallus is a challenging condition that significantly impacts the lives of infants and their families, so exploring this critical and often overlooked aspect of male reproductive health is essential [6]. The focus should be on managing microphallus during infancy and its consequences for adult sensual life. This comprehensive review demonstrates the critical importance of early intervention and management strategies to mitigate potential negative impacts on adult sensual life [7]. This review aims to provide a better scientific understanding of microphallus and micropenis and emphasize the importance of a holistic, multidisciplinary approach to managing these conditions. We aim to pave the way for improved clinical care, better patient outcomes, and a deeper understanding of the human phallic spectrum through heightened awareness and a comprehensive approach.
We conducted a thorough literature review to gather relevant information on micropenis and microphallus, including related disorders. Our primary databases were PubMed, Medline, and Google Scholar. We searched for articles published in English between 2000 and 2023. We included 67 review articles, 56 research studies, 11 case reports, one guideline, and one editorial. Our search terms were "microphallus", "micropenis", "congenital hypogonadotropic hypogonadism", "androgen insensitivity syndrome (AIS)", "pediatric management of micropenis", "testosterone therapy", and "psychosocial implications of micropenis". We extracted data from peer-reviewed scientific articles, case reports, and clinical studies. The study flow chart is shown in Figure 1.

We focused on diagnosing micropenis and related conditions, including hormonal assessments, medical and surgical treatment options, psychosocial and psychological well-being, sexual development of adolescents, and sociocultural influences on men's perceptions of penile size. We also looked into parenting and family dynamics in cases of micropenis and disorders of sex development, implications of hormonal treatment in neonates, and studies related to penile augmentation procedures and their effectiveness. We systematically reviewed, summarized, and synthesized the data extracted from the selected articles to provide a comprehensive overview of the diagnosis, management, and psychosocial considerations related to micropenis.

Our research indicates that micropenis is diagnosed based on penile length measurements. According to the included studies, micropenis is defined as an erect penile length of less than 9.3 cm (3.66 inches) in adults or more than 2.5 SDs below the mean in neonates and children. Figure 2 shows the rate of increase in penile length in both antenatal, postnatal, and adulthood. Micropenis is defined when the penile length is below -2 SD. The prevalence of micropenis varies between 0.6%-0.7% of male infants. Various underlying conditions, including congenital hypogonadotropic hypogonadism and AIS, can cause micropenis. These conditions can result in micropenis due to hormonal imbalances or insensitivity to androgens. The different causes of micropenis/microphallus are shown in Table 1. The penile growth is affected by different factors. Table 2 shows the different factors that affect the stretched penile length at birth, while Table 3 shows the factors affecting penile length from birth to adulthood. Figure 3 shows the prenatal and postnatal penile development and its relation to the testosterone surge. Hormonal assessment of micropenis is of critical importance for proper management. Figure 4 shows the flow chart for this assessment. Hormone therapy is often used to treat micropenis in neonates and young children. The administration of testosterone or human chorionic gonadotropin (hCG) can lead to increased penile growth, especially if initiated during the early stages of life. The treatment's success may depend on the underlying cause of micropenis. Surgical interventions, such as penile lengthening procedures, were identified as options for adults with micropenis who sought to increase penile length. Surgical interventions were generally considered a last resort due to associated risks and complications. Studies on penile augmentation procedures reported varying outcomes. Surgical interventions aimed at increasing penile length showed mixed results and patient satisfaction was influenced by individual expectations. Long-term implications of hormone therapy in neonates with micropenis are not always well-documented.

Micropenis can have a psychological impact on individuals. Adolescents and adults with micropenis often experience lower self-esteem and increased anxiety regarding their body image and sexual performance. Psychological support is essential to help individuals cope with these issues. Parents play an essential role in managing micropenis in infants. Studies noted the importance of family support in making decisions regarding treatment options and providing emotional support to their children. Societal perceptions of masculinity and penis size can exacerbate psychological distress related to micropenis. This influence has been shown to contribute to decisions for penile augmentation.

PENILE DEVELOPMENT

The male phallus is a remarkable example of biological diversity, showcasing the intricacies of embryonic development, endocrine regulation, and genetic influences. The process of penile development is a complex and highly regulated one that begins during early embryogenesis and continues throughout fetal growth, childhood, and puberty[8]. It is a well-orchestrated symphony of genetic signaling, hormonal cascades, and tissue differentiation, forming the male external genitalia and the mature penis. Understanding the intricacies of penile development is crucial in comprehending the causes of anomalies, such as microphallus and micropenis, appreciating the normal variations in penile size, and identifying potential areas of disruption in this delicate process[9].

Penile development begins during the embryonic phase and is mainly driven by genetic and endocrine influences. At around the sixth week of gestation, the bipotential genital tubercle, which is initially undifferentiated and a precursor to the external genitalia, undergoes sex differentiation in response to the genetic instructions encoded within the sex chromosomes[10]. This results in the formation of either a male or female form. The presence or absence of the sex-determining region Y (SRY) gene on the Y chromosome determines male or female development, respectively. In males, the SRY gene triggers a series of events that lead to the formation of the genital tubercle into the phallus, thus beginning penile development[11]. At the same time, the genital folds (also known as urethral folds) develop on either side of the genital tubercle. The genital tubercle, which is now committed to male development, undergoes a series of complex morphogenetic changes[8]. During this phase, androgens, primarily testosterone and dihydrotestosterone (DHT), play a pivotal role. By the seventh week of gestation, testosterone, produced by the Leydig cells in the developing testes, acts on the genital tubercle, stimulating its growth and elongation. Subsequently, the enzyme 5-alpha-reductase converts testosterone into DHT, a more potent androgen, which further amplifies penile growth and differentiation[12].

During fetal development, the genital tubercle elongates, and the urogenital folds, which flank the developing urethral groove, fuse together in the middle to form the penile urethra[13]. As the urogenital folds unite, the scrotal raphe begins to appear, creating the characteristic midline seam on the scrotal skin in males. This fusion not only separates the penile
Table 1 The causes of Microphallus and Micropenis

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
</tr>
</thead>
</table>
| Genetics                       | Specific genes mutations: Genes related to testosterone production and androgen receptor function. Genes associated with the genital tubercle development. AIS: Genetic deficiencies in Enzymes Involved in Hormone Production e.g., 5 alpha-reductase deficiency. Genetic abnormalities affecting hormonal signalling. Genetic disorders affecting pituitary gland function. Genetic causes of congenital adrenal hyperplasia (deficiency in steroidogenic acute regulatory protein (STAR gene mutation), 3 beta-hydroxysteroid dehydrogenases (salt-wasting, non-salt-wasting, and non-classic types), 17 α-hydroxylase (mutations in the CYP17A1 gene located on chromosome 10q24-q25). Chromosomal Abnormalities e.g., Klinefelter syndrome (XY), Trisomy of the chromosomes 8, 13, 18 or 21. Inherited syndromes: Bardet-Biedl syndrome, Prader-Willi syndrome and Kallman syndrome (hypogonadotropic hypogonadism, osteoporosis, hearing impairment, and anosmia). Noonan syndrome (hypertelorism, short neck, low-set ears, skeletal malformation, bleeding disorders, and pulmonary valve stenosis). Others: Charge syndrome, Silver Russel syndrome, Rad syndrome. Hormonal and endocrinial causes: Primary Hypogonadism: Either congenital or acquired e.g., Anorchia, Klinefelter and poly-X syndromes, gonadal dysgenesis (incomplete form), luteinizing hormone receptor defect (incomplete form), testosterone steroidogenesis (incomplete form), Noonan syndrome, Trisomy 21, Robinow syndrome, Bardet-Biedl syndrome, Laurence-Moon syndrome. Secondary Hypogonadism: Secondary to pituitary gland or hypothalamus disorders, resulting in decreased secretion of luteinizing hormone and follicle-stimulating hormone AIS: Enzyme deficiencies affect testosterone synthesis or its conversion to the more potent dihydrotestosterone. Growth hormone deficiency or abnormalities in IGF-1. Hypothyroidism. Adrenal gland disorders such as adrenal hyperplasia. Anatomical and structural abnormalities: Penile agenesis, cloacal dystrophy, hypospadias or chordee, Peyronie's disease, corpus cavernosa and corpus spongiosum hypoplasia, vascular abnormalities, ligaments or connective tissue abnormalities, and inadequate penile shaft length. Environmental factors: Antenatal exposure: Endocrine-disrupting chemicals, including phthalates, bisphenol A, and certain pesticides. Anti-androgenic drugs. Maternal substance abuse, including alcohol, drugs, or tobacco. Ionizing radiation. Antenatal infections. Inadequate nutrition and a poor maternal diet. Pollutant exposure such as heavy metals and dioxins. Antenatal exposure of antifungal. Postnatal exposure: Improper or excessive use of antibiotics or hormonal medications. Hormonal treatments for conditions like precocious puberty or delayed puberty. Surgical interventions or treatments for disorders affecting the genitalia. Idiopathic: Unknown cause.  

AIS: Androgen Insensitivity Syndrome; STAR: Spliced transcripts alignment to a reference; CYP17A1: Cytochrome P450 17A1; IGF-1: Insulin-like growth factor-1.  

urethra but also marks the scrotum, establishing male external genitalia[14]. Hormones and genetic factors regulate penile growth during fetal development, which follows a linear pattern until birth. This results in a newborn male having an adequate penile length at birth. During mid-to-late gestation, penile growth is essentially linear due to the increase in testosterone levels reaching the mid-gestation peak (Figure 3). For infants born between 24 wk-36 wk of gestation, penile length in centimeters can be calculated using the following equation: Gestational age in week multiplied by 0.16, then subtract 2.27[15].
This effect is observed in preterm infants. Babies who have a lower birth weight also tend to have shorter penises.[6] The duration of gestation can influence the development of the reproductive organs, including the penis. Premature babies may have a smaller penile length at birth than full-term infants.[7]

Penile growth in the first year of life is relatively slow, with an average stretched length of about 4.5 cm by age 12 months. This means that the penis grows approximately 1 cm in length during the first year of life; most of the growth occurs in the first six months due to the first post-natal testosterone surge known as mini puberty[18]. During the early years of life, the growth of the penis is minimal until puberty. Between the ages of one and five years, there is a slow and steady growth in both the length and width of the penis, which is influenced by growth hormones (GHs) and other factors. The growth rate remains consistent during the pre-pubertal stage (6 years-11 years) but is not as pronounced as during puberty.[19] The child's overall growth influences penile growth and anticipates the rapid growth that occurs during puberty. With the surge in testosterone levels during puberty, the penis undergoes significant growth in both length and girth.[20] This pubertal growth spurt, coupled with hormonal changes, signifies the completion of penile development into its adult form. The average adult penile length is about 9.16 centimeters when flaccid and 13.12 cm when erect. After puberty, there is unlikely to be any further penile growth. However, some individuals may experience penis growth into their early 20s.[21] Figure 2 shows the rate of increase in penile length in both antenatal, postnatal, and adulthood.

Table 2 Factors that affect the stretched penile length at birth

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic factors</td>
<td>Genetic factors influence the tissue response to androgens and can contribute to variations in penile size and development</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>There may be variations in penile length at birth among different ethnic groups. African and African-Caribbean ethnic backgrounds tend to have, on average, longer penile lengths compared to other ethnic groups. Individuals from Asian ethnic backgrounds tend to have slightly shorter penile lengths than African and African-Caribbean populations. Caucasian/European and Latino/Hispanic Ethnicities fall in the intermediate range in terms of penile length.</td>
</tr>
<tr>
<td>Prenatal testosterone levels</td>
<td>Hormones, particularly testosterone, play a crucial role in developing the male reproductive system, including the penis. Testosterone influences the growth of the penis during fetal development.</td>
</tr>
<tr>
<td>Gestational age</td>
<td>Premature babies may have a smaller penile length at birth than full-term infants. The duration of gestation can influence the development of the reproductive organs, including the penis.</td>
</tr>
<tr>
<td>Birth length</td>
<td>This effect is observed in preterm infants. Babies who have a lower birth weight also tend to have shorter penises.</td>
</tr>
<tr>
<td>Maternal Health and Nutrition</td>
<td>The health and nutrition of the mother during pregnancy can impact fetal development, including penile growth. Adequate nutrition and a healthy pregnancy can support normal development.</td>
</tr>
<tr>
<td>Fetal growth and development</td>
<td>The fetus's growth and development rate during pregnancy can affect penile length at birth. Factors such as intrauterine growth restriction can potentially influence penile size.</td>
</tr>
<tr>
<td>Certain medical conditions</td>
<td>Some medical conditions, such as Klinefelter syndrome and Down syndrome, can cause a decrease in SPL at birth.</td>
</tr>
<tr>
<td>Health conditions during pregnancy</td>
<td>Certain medical conditions during pregnancy, such as hormonal imbalances or endocrine disorders in the mother, can affect fetal development, including penile length.</td>
</tr>
<tr>
<td>Environmental factors</td>
<td>Environmental factors, including exposure to toxins, pollutants, or substances that can disrupt hormone levels, might impact penile development in utero.</td>
</tr>
<tr>
<td>Maternal exposure to certain medications</td>
<td>Some medications, such as corticosteroids and certain anticonvulsants, have been linked to a decrease in SPL at birth.</td>
</tr>
</tbody>
</table>

SPL: Stretched penile length.

The penis is typically small at birth, with an average stretched length of 3.5 cm in full-term newborn males. The penis may appear larger than expected due to increased adipose tissue, which is usually non-erect[16]. The foreskin is typically fused with the glans. A full-term baby’s stretched penile length at birth varies based on gestational age, while for preterm babies, it depends on both gestational age and body length.[17] It’s worth noting that it’s normal for newborns to have variations in penile size and that the size will continue to develop throughout childhood. Table 2 shows the factors that affect the penile length at birth. The postnatal growth rate of the penis is influenced by hormonal, genetic, nutritional, and health-related factors. Penile growth in the first year of life is relatively slow, with an average stretched length of about 4.5 cm by age 12 months. This means that the penis grows approximately 1 cm in length during the first year of life; most of the growth occurs in the first six months due to the first post-natal testosterone surge known as mini puberty (Figure 2)[18]. During the early years of life, the growth of the penis is minimal until puberty. Between the ages of one and five years, there is a slow and steady growth in both the length and width of the penis, which is influenced by growth hormones (GHs) and other factors. The growth rate remains consistent during the pre-pubertal stage (6 years-11 years) but is not as pronounced as during puberty.[19] The child’s overall growth influences penile growth and anticipates the rapid growth that occurs during puberty. With the surge in testosterone levels during puberty, the penis undergoes significant growth in both length and girth.[20] This pubertal growth spurt, coupled with hormonal changes, signifies the completion of penile development into its adult form. The average adult penile length is about 9.16 centimeters when flaccid and 13.12 cm when erect. After puberty, there is unlikely to be any further penile growth. However, some individuals may experience penis growth into their early 20s.[21] Figure 3 shows the rate of increase in penile length in both antenatal, postnatal, and adulthood.

It's important to understand that there are normal variations in penile growth among individuals, and each person’s growth trajectory may differ slightly due to genetic and environmental factors. Factors such as nutrition, general health, and physical activity can also play a role in the growth and development of the penis during childhood.[22] Table 3 shows the factors affecting penile length from birth to adulthood. It is crucial to understand the complex mechanisms and key milestones of penile development to identify and address any issues or abnormalities, such as microphallus and micropenis.[23] Further research into this process’s molecular and genetic basis may lead to potential therapeutic interventions to optimize penile development and improve outcomes for people with penile anomalies.
Table 3 The factors affecting penile length from birth to adulthood

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetics</td>
<td>The most important factor affecting penile length is genetics. Studies have shown that up to 80% of the variation in penile length can be attributed to genetics. Therefore, penile length is a highly heritable trait that is passed down from parents to children. In addition, certain genetic conditions can affect penile growth. For example, boys with Klinefelter syndrome tend to have smaller penises than boys without the disorder.</td>
</tr>
<tr>
<td>Race and ethnicity</td>
<td>Studies suggest that there may be differences in penile size among different ethnic and racial groups, although these variations are generally within a normal range and not significant.</td>
</tr>
<tr>
<td>Nutrition and Health</td>
<td>Proper nutrition and overall good health positively influence growth and development, including penile growth.</td>
</tr>
<tr>
<td>Puberty</td>
<td>Significant penile growth during puberty due to hormonal surges, especially testosterone.</td>
</tr>
<tr>
<td>Hormonal levels</td>
<td>Hormonal imbalances or medical conditions affecting hormone levels may influence penile growth. Testosterone, the primary male sex hormone, plays a critical role in the development and growth of the penis during puberty. Growth hormone also contributes to overall growth, including penile growth during adolescence.</td>
</tr>
<tr>
<td>Environmental factors</td>
<td>Some environmental factors, such as exposure to certain chemicals or toxins, may also affect penile growth. For example, boys exposed to phthalates, a type of chemical found in some plastics, had smaller penises than boys not exposed to phthalates. However, more research is needed to confirm these findings.</td>
</tr>
<tr>
<td>Medical conditions</td>
<td>Certain medical conditions or disorders, such as endocrine disorders and chronic illnesses, affecting endocrine function can influence penile length.</td>
</tr>
<tr>
<td>Obesity</td>
<td>Excess body fat can make the visible portion of the penis appear smaller due to the fat pad in the pubic area. Maintaining a healthy weight and reducing excess fat can help perceive penile length.</td>
</tr>
<tr>
<td>Circumcision</td>
<td>Surgical removal of the foreskin (circumcision) affects the appearance of the penis but not its actual length.</td>
</tr>
<tr>
<td>Exercising and physical activity</td>
<td>Regular physical activity and exercises targeting the pelvic area may help maintain good blood circulation and penile health.</td>
</tr>
<tr>
<td>Medical conditions and disorders</td>
<td>Some medical conditions or disorders can affect penile growth or cause anomalies in penile development. These can include hormonal disorders, congenital abnormalities, and certain genetic conditions. Disorders like Peyronie’s disease, characterized by fibrous scar tissue in the penis, can cause curvature and shortening of the penis.</td>
</tr>
<tr>
<td>Penis disorders and injuries</td>
<td>Trauma, surgical procedures, or diseases affecting the penis can cause changes in penile length. In some cases, surgical procedures might impact the size or appearance of the penis.</td>
</tr>
<tr>
<td>Age and aging</td>
<td>Natural changes in penile length and appearance as men age may occur due to changes in blood flow, tissue elasticity, and overall health.</td>
</tr>
</tbody>
</table>

Epidemiology

Microphallus can be identified at birth or during early childhood when the penis fails to develop to a normal size. However, it’s important to note that in some cases, this condition may not become apparent until puberty, when the male experiences delayed or insufficient growth of the penis[24]. There is a slight variation in the average penile length between different races and ethnic groups. For instance, the average penile length for White newborns is 2.6 cm, 2.5 cm for East Asian newborns, and 2.3 cm for Chinese newborns. African and African-Caribbean ethnic backgrounds tend to have, on average, longer penile lengths compared to other ethnic groups. Individuals from Asian ethnic backgrounds tend to have slightly shorter penile lengths than African and African-Caribbean populations. Caucasian/European and Latino/Hispanic Ethnicities fall in the intermediate range in penile length. The prevalence of microphallus/micropenis showed a wide variability in different parts of the world. However, it is generally reported to be about 1/300 male births. These variations between the countries depend on the diagnostic criteria used and the studied population. For example, the incidence of micropenis in North America is approximately 1.5 per 10000 male newborns[25]. A study from Brazil showed an increased incidence of micropenis to reach 6.6/1000. This high rate may be due to environmental (increased exposure to endocrine-disrupting chemicals) rather than racial differences[26]. Another study from Bulgaria showed that the incidence of micropenis was 6.4/1000 in children between 1 year-5 years[27]. Therefore, there is a huge discrepancy in the actual overall incidence of micropenis with a wide range of incidence, between 0.015%-0.66% of male neonates, due to a lack of standardization of measurement and the differences in racial and environmental circumstances[25,26].

Etiology of Microphallus and Micropenis

Microphallus and micropenis can be caused by various factors, including genetics, hormones, anatomy, and the environment[3]. Genetic mutations involved in male reproductive system development can result in microphallus[28]. AIS, a genetic disorder, can lead to underdeveloped or absent male genitalia, including a micropenis[29]. Hormonal imbalances during fetal development, caused by deficiencies in testosterone synthesis enzymes, can affect penile growth[30]. Conditions affecting the pituitary gland or chromosomal abnormalities like Klinefelter syndrome can be associated with microphallus[31]. Genetic syndromes such as Bardet-Biedl syndrome and Prader-Willi syndrome may include
Hormones, especially testosterone, play a crucial role in the normal growth and development of the male reproductive system, including the penis. Primary Hypogonadism and testicular function insufficiency can decrease testosterone production[32]. AIS reduces or eliminates the response to androgens, including testosterone, leading to underdeveloped male genitalia[33]. Enzyme deficiencies affecting testosterone synthesis or conversion can disrupt penile growth[33]. Disruptions in hormonal balance during fetal development can result in microphallus or micropenis[34]. Disorders affecting hormone production, such as adrenal gland dysfunction or pituitary gland/hypothalamus dysfunction, can impact penile development[35,36]. GH deficiency or abnormalities in insulin-like growth factor-1 (IGF-1) production can affect overall growth, including penile growth[37]. Severe or prolonged hypothyroidism in fetuses or infants can potentially affect genital development, causing micropenis[38].

Anatomical and structural abnormalities in the penis, such as severe hypospadias, chordee, or underdevelopment of erectile tissues, can lead to micropenis[39,40]. Vascular abnormalities that affect blood flow to the penis, as in Peyronie’s disease, can hinder proper penile growth[41]. Structural abnormalities in the ligaments or connective tissues supporting the penis can also contribute to a smaller penile size. Inadequate penile shaft length during fetal development can result in micropenis[42].

Environmental factors can disrupt hormone levels and impact penile development. Exposure to endocrine-disrupting chemicals like phthalates, BPA, and certain pesticides can interfere with hormone function during fetal growth[43]. Medications or hormones used during pregnancy, maternal substance abuse[45], radiation exposure[46], infections[47], inadequate nutrition[47], occupational exposure to chemicals, and improper use of antibiotics[48] or hormonal medications[49] can all potentially contribute to micropenis. Certain medical interventions and treatments for genital disorders can also result in a smaller penis[50]. In some cases, the cause of micropenis remains unknown, labeled as idiopathic micropenis[51]. Table 1 summarizes the common causes of micropenis.

### MEASUREMENT AND MONITORING OF PENILE LENGTH AND SIZE

Accurate diagnosis of microphallus and micropenis is crucial due to the significant psychological impact, stress, and anxiety imposed on the patients and their families[52]. Unfortunately, the measurement and monitoring of penile length...
Figure 2 The rate of increase in penile length in both antenatal, postnatal, and adulthood. Micropenis is defined when the penile length is below -2 SD. The figure idea is based on data from Tsang\cite{3}. SD: Standard deviation.

Figure 3 The prenatal and postnatal penile development and its relation to the testosterone surge. Note that any disruption of penile development during the critical window will cause microphallus, which is usually associated with congenital malformation such as hypospadias, while after that causes micropenis. Note the prenatal testosterone surge is associated with rapid penile growth of 0.7 mm/wk. The first postnatal testosterone surge occurs between the second and third month when the testosterone level reaches 260 ng/dL and is associated with rapid penile growth, known as mini puberty at six months of postnatal age. The second postnatal testosterone surge occurs at puberty and continues throughout adulthood. The figure idea and data were obtained from Chitayat and Glanc\cite{10}, Blaschko et al\cite{11}, Penington and Hutson\cite{13}, and Tuladhar et al\cite{15}.

and size in children during medical examinations is a controversial topic. Some experts believe that measuring and monitoring penile length and size is crucial to detect any abnormalities early on, while others consider it unnecessary and can be embarrassing for the child. However, measuring and monitoring penile length and size can be important for various reasons, including medical evaluation, research, and patient counseling\cite{53}. There is no consensus on measuring penile length and size in children, and experts have different recommendations. Some suggest measuring the length of the erect penis from the base to the tip, and others suggest measuring the length of the flaccid penis from the base to the
middle of the glans. Healthcare professionals may measure penile length and width during routine check-ups to monitor growth and development. Measurements are typically taken while the penis is stretched to obtain an accurate assessment. Stretched penile length is measured from the pubic ramus to the tip of the glans[54]. To measure the stretched penis, the flaccid penis is gently stretched horizontally, and the length is measured from the pubic bone to the tip of the glans while keeping the penis stretched as straight as possible[55]. The examiner should press the suprapubic fat pad inwards as much as he can and retract the foreskin, if present, during the measurement. Another way to stretch the penis is to use a modified syringe to make negative suctioning of the penis, stretching it while the suprapubic fat is pressed internally (Figure 5). A ten mL disposable syringe is cut off at the needle side, and the piston is re-inserted into the syringe on the cut side[7]. The open side of the syringe is applied to the penis to exert a negative suction of the penis by pulling back the piston, causing the penis to be pulled inside the syringe[7].

For measuring a flaccid penis (completely relaxed, not erect) while the infant or child is lying on the back, a penile ruler or tape measure is used to measure the penis from the pubic bone to the tip of the glans along the dorsal (top) side[56]. To measure a fully erect penis, a ruler or tape measure is used to measure from the pubic bone to the tip of the glans along the dorsal (top) side. The penis should be fully extended and straight during the measurement to obtain the most accurate length. The measurement should be from the pubic bone, which is the base of the penis, to the tip of the glans without any bends or curves[57]. Multiple measurements should be taken to increase accuracy, and the average should be calculated. The measurements should be recorded in both centimeters (cm) and inches (in) for reference and comparison. While measuring the child’s penile length, we should consider the wide natural variation in penile size and individual growth patterns. The physician should respect privacy and comfort during measurement, especially in clinical or medical settings[54].

Measuring penile length accurately is crucial in diagnosing true micropenis. A penile length measurement of 2.5 SD below the mean for age, in the presence of external and internal male genitalia compatible with a 46, XY male karyotype, is sufficient to diagnose micropenis[7]. Penile length can be measured using a penile ruler or measuring tape, or through specialized software and equipment that analyze images of the penis. This method involves taking standardized photographs and using computer software to measure penile length precisely; it is often used in research studies and clinical trials[58]. Penile plethysmography is a technique that measures changes in penile circumference or volume to assess sexual functioning and response, primarily in clinical and research settings[59]. Ultrasound imaging can provide detailed information about the anatomy of the penis, including measurements of penile length and diameter. It is often used in medical settings to evaluate penile abnormalities or during the assessment of erectile dysfunction[60].

Monitoring the length and size of the penis regularly can provide valuable insights into growth patterns and help address any concerns related to penile development. It is crucial to approach these measurements with sensitivity, especially when dealing with individuals who may have concerns about their penis size. To compare measurements with the average growth expected for a particular age group, we should use growth charts specific to penile length for age[61]. During puberty, we should periodically measure penile length (e.g., every 6 months-12 months) to track changes in size as the individual progresses through adolescence[62]. Measuring and monitoring the penile length and size can be
important for various reasons, such as assessing growth and development, diagnosing conditions like micropenis, or evaluating the effects of treatments. When measuring or monitoring penile length, following these guidelines for accurate results is crucial[42]. Firstly, use the same method and conditions, such as the same level of arousal and stretch, for each measurement. This ensures consistency and accuracy in the results. Secondly, providing a comfortable and private measurement environment is vital to reduce any anxiety or tension that might affect the measurements. Thirdly, remember that penile size varies among individuals, and there is a wide range of normal variation. Therefore, it is important not to base self-esteem or self-worth solely on penile size. It is really crucial to differentiate between a true micropenis and a pseudo-micropenis. In the latter condition, the penis seems small due to the prominence of surrounding tissue or due to the presence of a penile web that adheres the penis to the underlying skin. A thorough physical examination is essential to exclude pseudo-micropenis and avoid unnecessary invasive diagnostic procedures that can induce psychosocial stress for the patient and his family. Another surgical condition to be aware of is the chordee of the penis, which can cause an abnormally curved shaft and may falsely underestimate the penile length[63].

**DIAGNOSTIC WORKUP FOR CASES WITH MICROPHALLUS**

When clinical evaluations confirm microphallus or micropenis, further assessment is necessary to diagnose underlying conditions and plan appropriate treatment options. Search for signs of ambiguity or dysmorphism. General examination may give keys for diagnosis. For example, hearing impairment and anosmia may indicate the presence of Kallman syndrome, while cardiac defect may indicate Noonan syndrome. In some cases, genetic testing may be recommended to identify any genetic abnormalities that could be contributing to the condition[64,65]. Chromosomal analysis may reveal conditions such as Klinefelter syndrome (with an extra X chromosome), which can affect genital development. Hormonal evaluation is essential to determine if any hormonal imbalances could be causing the microphallus[16]. This may include measuring testosterone precursors, testosterone, DHT, luteinizing hormone (LH), follicle-stimulating hormone (FSH), prolactin, estradiol, and other relevant hormones such as cortisol, thyroid stimulating hormone, GH, and IGF-1. Low LH levels may indicate hypogonadotropic hypogonadism, and a magnetic resonance imaging (MRI) of the brain and pituitary functions evaluation is needed[66]. If LH is high, then we test for serum testosterone. A steroidogenic defect is suspected if serum testosterone is low with high LH. If serum testosterone is high with high LH, we may need to test for DHT levels[67]. Low DHT with high LH and testosterone levels and a high testosterone/DHT ratio may indicate 5α-Reductase 2 deficiency (5αR2D). High LH, testosterone, and DHT levels may indicate AIS[68]. A low testosterone/DHT ratio may indicate partial AIS. Serum electrolytes are also needed for any neonate presented with microphalus, especially when associated with any degree of ambiguity, as the risk for congenital adrenal hyperplasia is high, and the child may go into shock if not discovered early (Figure 4)[69].
Hormonal stimulation tests may be needed, especially those that involve stimulating the release of hormones, particularly GH or testosterone. Serum testosterone levels should be measured before or after administering hCG. Testosterone levels below 300 ng/dL after hCG stimulation suggest gonadal dysfunction[70]. Monitoring the body's response to these stimuli can help identify hormone deficiencies or abnormalities. Testicular insufficiency can be diagnosed if there is a rise in serum LH and FSH after hCG injection without a significant rise in serum testosterone[71]. Testosterone synthesis defects can be diagnosed by measuring 17 hydroxyprogesterone, androstenedione, and dehydroepiandrosterone levels before and after hCG injection. Mullerian-inhibiting hormone and inhibin B can be measured to indicate the presence of functional Sertoli cells and testicular tissue[72].

To assess the anatomy of the penis and surrounding structures, imaging studies such as ultrasound or MRI may be conducted depending on the clinical presentation[73]. Ultrasound imaging may be used to assess the anatomy of the genital region, including the penis and testicles[74]. It can help identify any structural abnormalities or congenital conditions affecting penile growth. MRI may be recommended to obtain detailed images of the penis and surrounding structures, particularly if ultrasound results are inconclusive. Brain MRI is useful for identifying midline structural defects, such as pituitary hypoplasia, dysplasia, or stalk dysplasia syndrome. If a person has a small posterior pituitary gland, a thinned or missing pituitary stalk, or posterior pituitary ectopia, these findings may suggest hypopituitarism[75]. Therefore, the cause of hypopituitarism can be determined through MRI imaging. Bone age assessment with an X-ray of the left hand and wrist can provide information about the individual's growth and development by assessing bone age[76].

A psychological evaluation may also be necessary to assess the psychological and emotional well-being of the individual, particularly in adolescents and adults, to address any concerns related to body image and self-esteem[77]. Every patient with microphallus should be assessed psychologically to evaluate their emotional well-being, mental health, body image, self-esteem, social interactions, academic performance, coping mechanisms, communication, family dynamics, decision-making, and long-term well-being[78]. It identifies mental health issues, evaluates the condition's impact on a child's perception of themselves and their body image, identifies social interaction difficulties, learning or concentration issues, and suggests appropriate interventions. The assessment also provides insights into the family dynamics and support system's influence on the child's mental health, evaluates their understanding and ability to make informed decisions, and helps design individualized psychological interventions[79]. The psychological assessment aims to assess a child's mental health and well-being, providing a comprehensive understanding of their psychological state, needs, and resilience factors, contributing to a better quality of life in the long term[80].

**MANAGEMENT OF MICROPHALLUS/MICROPENIS**

After adequate and proper evaluation of the microphallus by thorough clinical examination, hormonal assessment, and imaging studies, we need proper management through a multidisciplinary approach to address this condition's physical and psychological aspects. The main treatment goal in boys with micropenis is mainly based on increasing the length of the penis, assuming that it increases the child's self-esteem and body image, reassuring the parents, and alleviating their anxiety[81]. The management should be tailored to the individual's unique circumstances and needs, aiming to improve quality of life and address the condition's physical and psychological aspects. To ensure comprehensive and effective management, it's important to involve a team of healthcare professionals, including endocrinologists, urologists, psychologists, and counselors. Traditionally, the primary objective in treating boys with microphalus is centered on enhancing the penile length, believing that it positively impacts the boy's self-esteem and body image, simultaneously offering reassurance to the parents of the newborn[82].

**HORMONAL THERAPY**

Hormone replacement therapy, such as testosterone supplementation, may be considered if the microphallus is associated with hormonal deficiencies. After addressing the hormonal imbalances or deficiencies contributing to the micropenis development, hormonal therapy can help optimize the hormonal balance in the body, potentially promoting the growth and development of the penis. Therefore, the underlying defect should be confirmed before starting hormonal therapy, and the treatment will be tailored accordingly. Fortunately, sex hormone therapy helps in diagnosis and treatment as it helps assess androgen responsiveness. The timing of hormonal therapy should start early after the age of 6 months (after mini puberty)[83,84].

In idiopathic micropenis (80% of cases) and hypogonadotropic hypogonadism, testosterone is administered briefly to assess penile response through intramuscular injection, topical application, or suppository. Four doses of 25 mg (or 100 mg/m²) of intramuscular testosterone cypionate, enanthate, or undecanoate are given at 3-wk intervals to complete three months[85]. It helps to assess androgen responsiveness. The course can be repeated with shorter intervals if there is no adequate response. The three different forms of intramuscular testosterone differ in their duration of action, with testosterone enanthate lasting for the shortest time, while undecanoate lasting the longest; therefore, it is given at 4-wk intervals[86]. Unfortunately, there is no consensus on dosage, administration method, or testosterone treatment duration for children with micropenis. Side effects are minimal, although temporary growth rate acceleration, advancement of bone age, premature growth spurt, and precocious puberty may occur. Other side effects may occur, such as pain at the injection site, headache, high blood pressure, and pronounced gynecomastia[87]. Intramuscular testosterone therapy is associated with a good response that typically involves a 100% increase in penile length during the initial treatment.
Additionally, testosterone therapy is used to treat scrotal hypoplasia in young children. Rectal testosterone is used in some cases with hypogonadotropic hypogonadism (panhypopituitarism and congenital hypogonadotropic hypogonadism) in a daily dose of 1 mg-5 mg and exhibited an increase in penile length and scrotum width. An increase in penile length of 3.5 cm is considered an adequate response. Adding aromatase inhibitors could increase the response to testosterone therapy[88]. Anastrozole is a nonsteroidal aromatase inhibitor that decreases the amount of estrogen in the body. Papadimitriou added oral anastrozole in a dose of 1 mg/d to intramuscular testosterone enanthate for three months to treat idiopathic-isolated-relative micropenis at the beginning of puberty. They showed a significant improvement in penile length by about 20%, while no effect on height velocity and bone maturation[89].

Topical testosterone also shows a good effect. Arisaka et al[90] showed increased penile lengths in 50 infants and children aged between five months and eight years by administering 5% testosterone cream for 30 d. Topical testosterone can stimulate GH secretion and promote bone growth, indicating the long-term effect of topical testosterone application on promoting both skeletal and penile growth[90]. Clinical studies have indicated positive effects of testosterone treatment on penile growth during infancy; however, whether this growth continues into adolescence and adulthood remains unclear. Topical dihydrotestosterone gel has been used to treat underutilized children with 5α-reductase deficiency or with partial AIS, an alternative to intramuscular testosterone, since 1990[91]. Table 4 compares between micropenis due to 5αR2D and AIS, including management.

When applied topically, DHT gel absorption can be unpredictable and inconsistent. There is also a risk of cross-contamination if the application instructions are not followed properly, which can affect people in close contact. The procedure for applying DHT transdermal gel to genital skin lacks standardization, with varying doses and durations reported in different studies[106]. Some studies show a significant increase in stretched penile length due to DHT treatment, while others report adverse effects such as changes in lipid profiles and mild skin reactions. The response to DHT treatment, as measured by stretched penile length, can vary depending on the underlying diagnosis and age at which therapy is started. DHT treatment has increased stretched penile length in pre and peripubertal patients with partial AIS and 5α-reductase deficiency but not in adults[92,93]. Reduced androgen sensitivity in DHT-dependent tissues due to intracellular DHT deficiency may explain the limited effect of exogenous DHT in 5α-reductase deficiency[13]. It is important to determine the best age for therapy to maximize its effect. Micropenis is preferably treated in infancy (better to be after mini puberty and before 2 years of age) or at the onset of puberty[94]. Research suggests that this may be related to the time when androgen sensitivity is at its peak. The high expression of androgen receptor (AR) in early infancy suggests that androgens may be useful at this stage. However, it is unclear whether early use of androgens has any long-term benefits on penile length in adulthood[95,96]. Selective androgen receptor modulators (SARMs) are currently in the developmental phase and are pending approval. One anticipated benefit of SARMs is their proposed selectivity with fewer systemic side effects[97].

Gonadotropins are essential to the maturation and proper functioning of gonads. In 1993, Almaguer et al[98] documented the first use of hCG for micropenis treatment. They found that six neonates experienced significant penile growth following three daily intramuscular injections of 1500 IU of hCG[98]. Since then, recombinant gonadotropins have been suggested as an alternative treatment to testosterone for male infants and peripubertal boys with congenital hypogonadotropic hypogonadism. This treatment aims to replicate the physiological activation of the hypothalamic-pituitary-gonadal axis[99]. The first case of recombinant gonadotropin treatment for congenital hypogonadotropic hypogonadism was reported in 2002 by Main et al[100]. This treatment included recombinant LH (20 IU-40 IU) and FSH (21.3 IU) administered twice weekly for approximately seven months. The treatment successfully improved penile length and stimulated tesicular growth and physiological mini-puberty[100]. Other studies have also noted the effectiveness of gonadotropin treatment in increasing stretched penile length in boys with congenital hypogonadotropic hypogonadism during their first year of life. Bougnères et al[101] described continuous gonadotropin infusion by an insulin pump to treat two newborns with micropenis and congenital hypogonadotropic hypogonadism. Patient 1 began subcutaneous infusion at eight weeks with rhLH 56 IU and rhFSH 67 IU daily until 25 wk of life. Patient 2 initiated subcutaneous infusion at 20 wk with rhLH 50 IU and rhFSH 125 IU daily until 48 wk of life. This treatment resulted in stretched penile length increasing from 8 mm to 30 mm in the first newborn and from 12 mm reaching 48 mm in the second newborn, accompanied by increased tesicular volume and elevated serum testosterone, inhibin B, and anti-mullerian hormone levels in both neonates[101]. However, comprehensive reports on gonadotropin treatment during the neonatal and infant periods still need to be made available. Further research is necessary to compare the relative efficacy of hCG and LH, given differences in their half-life. Additionally, long-term studies are required to investigate outcomes like fertility.

GH therapy is a controversial but viable treatment option for micropenis, especially when it is linked to GH deficiency or short stature. GH promotes the growth of various tissues, including genitalia, and its application in micropenis cases aims to enhance overall growth and potentially improve penile size[102]. Oh et al[103] found synergetic effects of GH therapy on penile growth by enhancing the AR expression levels and reducing the tesicular volume losses. However, the response to GH therapy may vary among individuals. The duration of treatment is determined based on an individual’s specific growth needs but often needs an extended period. A multidisciplinary team of healthcare professionals, including pediatric endocrinologists and urologists, evaluates and monitors the effectiveness of the therapy. While GH therapy can be beneficial in certain cases, its impact on penile growth may not be significant for all individuals, and its use is tailored to the patient’s unique condition and health requirements. The decision to use GH therapy is made within a comprehensive treatment plan considering the patient’s overall health and underlying causes of micropenis. It may also be combined with other treatments for a multimodal approach[104].

Combined hormonal therapy for micropenis typically involves the administration of both testosterone and other hormones, such as gonadotropins, gonadotropin-releasing hormone analogues, aromatase inhibitors, topical DHT, GH, or other hormones that play crucial roles in male sexual development and function[23,99,100,103,105]. The decision to pursue combined hormonal therapy is based on a thorough evaluation of the underlying causes of micropenis, which
Table 4 Differences between 5α-reductase type 2 deficiency and androgen insensitivity syndrome

<table>
<thead>
<tr>
<th>5αR2D</th>
<th>AIS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary genetic defect</strong></td>
<td>Genetic mutations in the androgen receptor gene result in the inability of cells to respond to androgens (e.g., testosterone)</td>
</tr>
<tr>
<td><strong>Inheritance</strong></td>
<td>X-linked recessive</td>
</tr>
<tr>
<td><strong>Chromosome location</strong></td>
<td>Xq11-q12</td>
</tr>
<tr>
<td><strong>Genotype</strong></td>
<td>Typically, 46, XY karyotype (male genotype)</td>
</tr>
<tr>
<td><strong>Phenotype</strong></td>
<td>Variable degrees of feminization and incomplete masculinization despite the presence of male internal and external genitalia</td>
</tr>
<tr>
<td><strong>Hormonal profile</strong></td>
<td>Elevated testosterone levels due to a lack of androgen receptor responsiveness, elevated LH, and normal MIF</td>
</tr>
<tr>
<td><strong>Response to androgens</strong></td>
<td>Lack of response to androgens despite normal or elevated testosterone levels</td>
</tr>
<tr>
<td><strong>Internal reproductive organs</strong></td>
<td>Typically have normal male internal reproductive organs (e.g., testes, vas deferens, epididymis). Testes located in the inguinal canal or scrotum</td>
</tr>
<tr>
<td><strong>External genitalia</strong></td>
<td>Typically, they have normal male internal reproductive organs. Testes located in the abdomen or inguinal canal</td>
</tr>
<tr>
<td><strong>Pubertal development</strong></td>
<td>Minimal virilization, with absent or minimal facial hair, high-pitched voice, and breast development</td>
</tr>
<tr>
<td><strong>Fertility</strong></td>
<td>Infertility due to absent or underdeveloped reproductive organs</td>
</tr>
<tr>
<td><strong>Psychological Impact</strong></td>
<td>Gender dysphoria may occur due to female-appearing genitalia and lack of virilization</td>
</tr>
<tr>
<td><strong>Treatment</strong></td>
<td>Hormone replacement therapy is not effective due to insensitivity to androgens. In complete type, the patient is treated as female, and estrogen therapy is indicated with orchidectomy. Orchidectomy aims to prevent possible malignant degeneration of the testes. Psychological support and surgical interventions may be considered</td>
</tr>
</tbody>
</table>

5αR2D: 5α-Reductase Type 2 Deficiency; AIS: Androgen Insensitivity Syndrome; DHT: Dihydrotestosterone; LH: Luteinizing hormone; MIF: Müllerian-inhibiting factor.

may include genetic factors, hormonal imbalances, or other medical conditions[7]. The primary goal of combined hormonal therapy is to correct hormonal imbalances that may contribute to micropenis. For example, combined treatment may address testosterone and gonadotropin deficiencies, which are essential for normal penile development[16]. The specific combination and dosage of hormones used in combined hormonal therapy are individualized based on the patient's medical history, hormonal profile, and specific needs. Combined hormonal replacement therapy is more likely to be associated with potential side effects, such as changes in blood lipid profiles, fluid retention, and mood swings[106]. Therefore, regular monitoring of hormone levels and physical and clinical assessments are crucial to assess the therapy's effectiveness and side effects and adjust the treatment plan as needed. Table 5 summarizes advantages and disadvantages of various hormonal therapies for microphallus.

**SURGICAL MANAGEMENT**

Surgical management of micropenis has come a long way since the early 1970s[107]. Guidelines for penile elongation were established in 1996 by Wessells et al[108], which recommended surgical intervention only for men with a penile length of less than 4 cm in the flaccid state or 7.5 cm in the stretched state. However, surgical management of micropenis in infants and children is a complex and highly specialized area of pediatric urology. The medical team usually waits until the child reaches an appropriate age, often in late adolescence or adulthood, due to the ongoing growth and development of the genitalia.
### Table 5 Advantages and disadvantages of various hormonal therapies for microphallus

<table>
<thead>
<tr>
<th>Hormonal therapy</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intramuscular testosterone</td>
<td>Promotes penile growth and development by addressing testosterone deficiencies. Enhances the development of secondary sexual characteristics. Improves muscle mass, bone density, and overall well-being</td>
<td>Potential side effects include acne, mood swings, increased aggression, and accelerated skeletal maturation. May suppress natural testosterone production if used long-term. Requires regular monitoring of hormone levels and administration through injections or topical applications</td>
</tr>
<tr>
<td>Topical</td>
<td>Non-invasive administration, more comfortable. Gradual absorption with more stable and consistent hormone levels. Less Pain and Discomfort. Easy Application and more convenient treatment option</td>
<td>Erratic absorption with hormonal fluctuations, limited efficacy, and uncertain outcomes. Risk of transfer to others, especially children and women, through close physical contact with the application site. Skin Sensitivity and allergic reactions to the topical product. Lack of Standardization</td>
</tr>
<tr>
<td>hCG</td>
<td>Stimulates the testes to produce testosterone, aiding in penile growth. Can be used in combination with other hormonal therapies for enhanced results. Administration via injections or subcutaneous pellets</td>
<td>Potential side effects may include fluid retention, breast tenderness, and mood swings. Requires careful monitoring and adjustment of dosages to avoid adverse effects</td>
</tr>
<tr>
<td>Aromatase inhibitors</td>
<td>Inhibit the conversion of androgens to estrogen, potentially increasing testosterone levels and aiding penile growth. May be considered for individuals with aromatase excess syndrome</td>
<td>Limited evidence on efficacy and safety for promoting penile growth. Possible side effects include joint pain, mood swings, and bone density issues</td>
</tr>
<tr>
<td>GH therapy</td>
<td>Stimulates growth and may indirectly impact penile growth. Beneficial for children with growth hormone deficiencies or short stature</td>
<td>Limited evidence regarding the direct impact on penile growth in micropenis cases. Potential side effects include fluid retention, joint pain, and increased risk of diabetes</td>
</tr>
<tr>
<td>GH therapy</td>
<td>Combines multiple hormones (e.g., testosterone, hCG) to synergize and enhance penile growth potentially. May optimize hormonal treatment effectiveness for promoting penile growth</td>
<td>Increased complexity of treatment regimen with potential for elevated side effects due to multiple hormonal agents. Requires vigilant monitoring and management of potential adverse effects</td>
</tr>
</tbody>
</table>

hCG: Human chorionic gonadotropin; GH: Growth hormone.

Surgical interventions for micropenis are typically deferred until the child reaches an appropriate age, often in late adolescence or adulthood, due to the ongoing growth and development of the genitalia. It is often reserved for the most extreme cases. The medical team carefully considers the timing of surgery. Surgical procedures can vary depending on the specific needs of the child. Common surgical techniques may include penile lengthening, girth enhancement, visual appearance improvement, augmentation phalloplasty, or even replacement of the phallus. Penile lengthening procedures aim to increase penile length through various techniques, such as releasing the suspensory ligament or V-Y dorsal incisions[109,110]. On the other hand, girth enhancement procedures aim to increase penile girth, often involving fat grafting or the injection of hyaluronic acid[111]. A complete replacement of the penis with an augmentation phalloplasty is considered in augmentation phalloplasty. This technique is a more extensive surgical procedure. Other methods like sliding elongation and penile disassembly, have also been documented[112].

Surgical management of micropenis carries potential risks, including limited increase in penile length (1 cm-3 cm), scarring, changes in sensation, and effects on sexual function. The potential benefits include improved penile size and appearance[113,114]. Perceived penile length can be enhanced by eliminating suprapubic fat, achievable through weight reduction measures or surgical removal using liposuction or more extensive procedures[115]. However, despite the advancements in surgical techniques, they cannot fully replicate the normal anatomy and function of the penis. It is important to carefully consider these procedures’ risks, benefits, and potential outcomes. Further research is essential to identify the optimal surgical procedure, focusing on long-term patient satisfaction and minimizing postoperative complications.

### PSYCHOLOGICAL COUNSELING, EDUCATION, AND SUPPORT

Psychological support and counseling are essential for managing microphallus and micropenis. Mental health professionals can assist individuals in coping with the emotional and psychological difficulties associated with the condition, leading to improved self-esteem and overall well-being. Counseling and support are crucial for infants, children, and adolescents with micropenis to help them navigate their physical, emotional, and social challenges. Micropenis can profoundly impact a person's self-esteem, body image, and overall well-being[116].

Pediatricians can provide psychological counseling and support during the different stages of development. During infancy, pediatricians can offer emotional support and guidance to parents concerned about their child’s condition[117]. Accurate information about micropenis and potential treatment options must be provided. They can also properly connect parents with pediatric endocrinologists and urologists who can assess the cause of the micropenis and recommend treatment, if necessary. During childhood, integration between pediatricians, families, and schools is crucial. Depending on the child's age and maturity, age-appropriate education can be provided, delivering information about
micropenis in a way that is appropriate for their age[118]. This education should explain that physical differences are normal and not a cause for shame. Positive self-esteem and body image can be encouraged by emphasizing a child’s other qualities, talents, and achievements. Children should understand that their self-worth goes beyond physical appearance. Strategies should be taught to help them deal with teasing or bullying if it arises, and children should be encouraged to communicate with parents and educators[119].

Puberty is a critical stage for all individuals, especially those with micropenis. Adolescence can be incredibly challenging for those with micropenis, as it is a period of increased self-awareness and self-identity. Therefore, building self-esteem, self-acceptance, and self-compassion is crucial to providing accurate information about sexual health, relationships, and intimacy that is appropriate for their age. Adolescents should learn the importance of communication, consent, and safe sexual practices[120]. They should be encouraged to seek out supportive friends and groups focusing on self-acceptance and diversity. Joining support groups or engaging in therapy sessions with individuals facing similar challenges can provide emotional support and a sense of community. Sharing experiences and coping strategies can benefit those dealing with the condition. If adolescent struggles with body image issues, depression, or anxiety related to their condition, we should consider referring them to a therapist or counselor experienced in dealing with body image and self-esteem issues[121].

In all stages of development, open and non-judgmental communication between the child or adolescent, their parents, and healthcare providers is essential. Professionals should approach this topic with sensitivity and respect, focusing on the individual's emotional well-being and overall development. Additionally, interventions to address micropenis, such as hormone therapy or surgery, should be discussed and decided upon with the individual's and their parent's full consent, when applicable. Ultimately, the goal is to help individuals with micropenis develop a healthy self-image, self-confidence, and a positive outlook on their future, regardless of their physical condition[122].

LIFESTYLE MODIFICATIONS

Lifestyle modifications for children and adolescents with micropenis aim to create a supportive and healthy environment that fosters self-confidence and overall well-being. This modification includes promoting healthy body image and self-esteem, providing accurate information about their condition, teaching strategies to address bullying or teasing, and encouraging peer and social support[123]. Additionally, emphasizing a healthy lifestyle, including a balanced diet, adequate sleep, exercise, and hygiene, is essential and can positively impact overall well-being. Healthy lifestyle habits contribute to better physical health and may indirectly improve self-esteem and body image. Sex education should be part of the education, focusing on relationships, consent, and safe practices. Seeking professional help for psychological distress, considering medical consultation and treatment options, and maintaining a supportive family environment are also vital[124]. The approach for lifestyle modifications should be individualized, considering the child or adolescent’s unique needs and circumstances. It is essential to provide a safe and supportive environment where the affected individuals feel accepted and loved regardless of their physical condition. Ultimately, the goal is to empower these individuals to thrive, set goals, and develop a positive self-image regardless of their physical condition[125].

CONSEQUENCES OF MICROPHALLUS/MICROPENIS

Throughout various historical epochs, the size of the male genitalia has been considered a symbol of masculinity, leading to extensive debate in societies with distinct social and cultural nuances. Apart from its role in sexual intercourse, the penis has been associated with male fertility and sexual performance, making its size a crucial aspect of male identity. The use of phallic size to support male dominance and superiority has been common in various cultures and historical periods and has continued to be reinforced by contemporary media, especially in the adult entertainment industry[126, 127]. This societal view that links the length of the penis to masculinity has placed a heavy burden on those who suffer or believe they suffer from microphallus.

A micropenis, or microphallus, can have significant physical, psychological, and social impacts on those affected. A smaller-than-average penis can lead to sexual difficulties, affecting sexual self-esteem and relationships due to challenges during sexual intercourse, including penetration and maintaining an erection[128]. This condition may also be linked to other reproductive system abnormalities, potentially impacting fertility and family planning. Dealing with a micropenis often brings about profound psychological distress, causing feelings of shame, embarrassment, anxiety, depression, and lowered self-esteem due to societal expectations about male genitalia[129]. These emotional struggles can have a lasting effect on mental well-being. Social interactions and relationships can be strained, as individuals with a micropenis often face stigma, discrimination, or teasing, impacting both romantic and platonic relationships. Daily activities related to personal hygiene, urination, and other functions may also pose challenges due to the size of the penis, affecting overall quality of life[130]. Seeking resolution, individuals with micropenis may explore medical interventions such as hormone therapy, penile lengthening procedures, or psychological counseling to address the physical and psychological aspects of the condition. However, these interventions can be invasive, costly, and may not always provide satisfactory results[131].

Dealing with a micropenis can challenge traditional notions of masculinity and male identity, given the societal association of penis size with masculinity and sexual prowess, adding to the psychological burden[132]. Individuals with micropenis may encounter difficulties in educational or professional settings due to the psychological stress or anxiety tied to their condition, potentially affecting their career prospects and advancement opportunities. Effectively addressing the consequences of a micropenis requires a holistic approach involving medical care, psychological support, education,
and societal awareness initiatives to promote understanding and acceptance[133].

**MONITORING AND FOLLOW-UP**

It is crucial to monitor and follow up with infants, children, and adolescents who have a micropenis. For infants, it is vital to have regular check-ups with a pediatrician and hormone assessments to rule out any underlying conditions[134]. During childhood, annual check-ups should continue, emphasizing psychological support and education to promote positive body image and address potential bullying. For adolescents, annual check-ups and psychological support are essential, along with sex education, peer support, and consultation with specialists for potential treatments[135]. Long-term follow-up into adolescence and beyond is necessary to provide continued mental health support, health check-ups, reassessment of treatment options, and maintaining a supportive family environment. The goal is to provide comprehensive care that addresses the physical and psychological aspects of micropenis and adapts to the individual's needs as they grow[136]. Table 6 summarizes follow-up care for various life stages of patients with micropenis.

**LIMITATIONS OF THE STUDY**

This study has some limitations. First and foremost, it relies heavily on the quality and reliability of data from existing literature, which may exhibit variations in accuracy and consistency across different sources. Moreover, the presence of publication bias is a significant concern, as it can skew the selection of studies towards those with notable findings, potentially affecting the overall conclusions. Additionally, data selection bias may be inherent in the process of choosing relevant literature, favoring studies with specific focuses, which might only encompass part of the subject matter. Notably, the absence of primary research data poses a substantial limitation, as the study primarily draws from secondary sources. The heterogeneity among the included studies regarding methodologies, populations, and diagnostic criteria can impede the synthesis of results and generalizability. Temporal bias is a consideration since the included literature might need to reflect current medical practices and criteria. The study might also exhibit language bias if confined to literature published in a specific language, potentially excluding relevant research in other languages. Moreover, the scope may only encompass micropenis cases and treatment options from some demographics and regions, affecting the generalizability of the findings. The influence of conflicts of interest, particularly in studies discussing treatment modalities, presents another potential bias. The psychological aspects discussed in the study can introduce complexities and subjectivity in interpreting results, as the psychological impact of micropenis varies among individuals. Identifying research gaps highlights the limitations in data sufficiency and the potential lack of effective data for certain treatments. Therefore, while this study provides valuable insights, these limitations should be considered when interpreting its findings and identifying areas for future research and methodology improvement.

**TAKE-HOME MESSAGE**

This comprehensive review of micropenis and its treatment options underscores the importance of multidisciplinary care, considering both medical and psychological aspects of this condition. The findings emphasize the need for early diagnosis and intervention to address affected individuals' physical and psychological well-being. While surgical interventions like penile lengthening procedures show promise, the long-term efficacy and safety require further investigation. Non-surgical approaches, such as hormonal therapy and psychological support, also play vital roles in the management of micropenis.

**RECOMMENDATIONS**

Neonatologists should measure stretched penile length in all neonates at birth. Neonatologists should consider micropenis with non-palpable gonads as an emergency. The presence of isolated micropenis suggests gonadotropin deficiency. Timely assessment and management of micropenis are crucial. Healthcare professionals should prioritize early diagnosis of micropenis and provide comprehensive counseling for individuals and their families. Early intervention can significantly alleviate the psychological distress associated with this condition. A multidisciplinary team, including urologists, endocrinologists, and mental health professionals, should collaborate in managing micropenis to address both the physical and psychological aspects. We also need to regularly assess the effectiveness of treatment approaches and update guidelines and best practices based on new evidence and evolving medical technologies.

**CONCLUSION**

Early management and comprehensive care for micropenis during infancy, childhood, and adolescence are crucial to ensuring the physical and emotional well-being of the affected individuals. This article highlights the significance of
Table 6 Follow-up care for various life stages of patients with micropenis

<table>
<thead>
<tr>
<th>Life stages</th>
<th>Follow-up protocols</th>
</tr>
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<tbody>
<tr>
<td>Infants (0-2 yr)</td>
<td>Regular Pediatric Check-ups: Schedule routine pediatric visits to monitor growth and development. Hormone Assessment: If micropenis is identified in infancy, consult a pediatric endocrinologist to evaluate hormone levels and rule out any underlying medical conditions. Parental Education: Inform parents about micropenis and any potential treatment options</td>
</tr>
<tr>
<td>Children (3-12 yr)</td>
<td>Annual Check-ups: Continue with regular pediatric check-ups, focusing on growth and development. Psychological Support: Provide psychological counseling for both child and parents and encourage open communication to address self-esteem or body image issues. Education and Awareness: Ensure the child has accurate information about their condition and promote a positive body image. Bullying Awareness: Discuss bullying prevention strategies and provide resources if needed</td>
</tr>
<tr>
<td>Adolescents (13-18 yr)</td>
<td>Annual Check-ups: Transition to annual check-ups focusing on overall health. Psychological Support: Continue to offer psychological support, especially given the increased self-awareness and potential body image concerns during adolescence. Sex Education: Provide age-appropriate sex education, discussing relationships, consent, and safe sexual practices. Peer and Social Support: Encourage the adolescent to seek out supportive friends and support groups. Consultation with Specialists: It is recommended to consult with a pediatric endocrinologist or urologist to evaluate the need for potential treatments like hormone therapy or surgery. The adolescent should be fully informed and involved in decision-making</td>
</tr>
<tr>
<td>Long-term follow-up (throughout adolescence and beyond)</td>
<td>Mental Health Support: It's important to provide mental health support to individuals who may be struggling with body image or self-esteem issues. Regular Health Check-ups: It's also important to encourage regular health check-ups to monitor overall health and well-being. Reassessment of Treatment Options: Periodically reassessing the need for medical interventions in consultation with healthcare specialists is also recommended. Supportive Family Environment: Maintaining a supportive and open family environment where individuals feel comfortable discussing their concerns and seeking help if needed is crucial</td>
</tr>
</tbody>
</table>

timely intervention and support. By providing accurate information, fostering self-esteem, addressing bullying, and seeking professional guidance when necessary, we can empower individuals to navigate their journey toward a fulfilling adulthood with positivity and confidence. It is vital for healthcare professionals, parents, and those affected to work together to create a supportive and understanding environment that recognizes that physical differences do not define one's worth. By doing so, we can help ensure that those with micropenis can lead healthy, happy, and fulfilling lives.

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