MELİS ÜNAL PHYSIOTHERAPY AND REHABILITATION MASTER THESIS 2023

T.C.

YEDITEPE UNIVERSITY

INSTITUTE OF HEALTH SCIENCES

DEPARTMENT OF PHYSIOTHERAPY AND REHABILITATION

EFFECTS OF CONNECTIVE TISSUE MANIPULATION ON CLINICAL SYMPTOMS AND PELVIC FLOOR MUSCLE FUNCTIONS IN CHILDREN WITH LOWER URINARY TRACT DYSFUNCTION

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APPROVAL

This thesis has been deemed by the jury in accordance with the relevant articles of Yeditepe University Graduate Education and Examinations Regulation and has been approved by Administrative Board of Institute with decision dated .... and numbered ....

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DECLARATION

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree except where due acknowledgment has been made in the text.

Melis ÜNAL, PT

DEDICATION

To my family…

ACKNOWLEDGEMENTS

First of all, I would like to thank my valuable advisor, Assist. Prof. Elif Develi, who always supported me during both my education and thesis periods with her helpfulness, friendliness, and calmness. While she supported me with all her sincerity throughout my thesis period, she also provided me with real confidence. She also played an important role by making great contributions to the entire Physiotherapy and Rehabilitation education process. I'm grateful for all their support.

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LIST OF SYMBOLS AND ABBREVIATIONS

ADHD	Attention Deficit and Hyperactivity Disorder
BBD	Bladder and Bowel Dysfunction
CIC	Clean Intermittent Catheterization
CTM	Connective Tissue Manipulation
CTG	Connective Tissue Group
DB	Diaphragmatic Breathing
DV	Dysfuntional Voiding
DVISS	Dysfunctional Voiding and Incontinence Scoring System
EBC	Expected Bladder Capacity
EMG	Electromyographic measurement
FES	Functional Electrical Stimulation
ICCS	International Children’s Continence Society
LUT	Lower Urinary Tract
LUTD	Lower Urinary Tract Dysfunction
MNE	Monosymptomatic Enuresis
MVV	Maximum Voided Volume
NE	Nocturnal Enuresis
NMNE	Non- monosymptomatic Enuresis
OAB	Overactive Bladder
PAG	Periaqueductal Gray
PFG	Pelvic Floor Group
PFM	Pelvic Floor Muscles
PFMR	Pelvic Floor Muscle Rehabilitation

PFMT	Pelvic Floor Muscle Training
PVR	Post-void residual urine
PIN-Q	Pediatric Urinary Incontinence Quality of Life Score
RCT	Randomized Controlled Trial
TENS	Transcutaneous Electrical Nerve Stimulation
UAB	Underactive Bladder
UI	Urinary Incontinence
UTI	Urinary Tract Infection
Qmax	Maximum Flow Rate
Qave	Average Flow Rate

ABSTRACT

Ünal, M. (2023). Effects of Connective Tissue Manipulation on Clinical Symptoms and Pelvic Floor Muscle Functions in Children with Lower Urinary Tract Dysfunctions.

Yeditepe University Institute of Health Sciences, Department of Physiotherapy and Rehabilitation Master Thesis, Istanbul.

The aim of this study is to evaluate the effects of connective tissue manipulation (CTM) applied in addition to pelvic floor muscle rehabilitation (PFMR) on LUTD symptoms, pelvic floor muscle (PFM) activation, uroflowmetry and bladder diary parameters, and quality of life compared to PFMR applied alone in children with lower urinary tract dysfunction (LUTD). 40 children with LUTD were included in the study. Children were divided into two groups as PFMR+CTM (n:20)(CTG) and PFMR (n:20)(PFG) by block randomization. PFMR and CTM were applied 3 days a week for a total of 8 weeks. Uroflowmetry parameters with EMG-Uroflow, PFM activation with Myoplus Pro 4 device, post-void residual urine (PVR) with ultrasonography, bladder functions with bladder diary, symptom severity with Dysfunctional Voiding and Incontinence Scoring System (DVISS), quality of life with the Pediatric Urinary Incontinence Quality of Life Score (PIN-Q) was evaluated. All assestments were performed baseline and post-test. After itntervention, a decrease in symptoms, improvement in uroflowmetry, PVR and bladder diary parameters, and improvements in PFM activation values and quality of life were observed in both groups ($p<0.05$). Between-group comparisons showed a greater decrease in the DVISS score on CTG, a greater increase in the QAve value on uroflowmetry and voided volume in the bladder diary, a greater increase in the contraction average activation of the PFM, and a greater decrease in the Pin-Q questionnaire ($p=0.001$). To our knowledge, our study is the only study that uses and compares PFMR and CTG together in children with LUTD. As a result, PFMR is an effective method on symptoms, uroflowmetry and bladder diary parameters, PFM activation and quality of life when applied both alone and together with CTM. However, when applied together with CTM, the symptom score, some uroflowmetry and bladder diary parameters are more effective in the development PFM contraction activation and quality of life. It can be preferred as an effective method without side effects in children with LUTD.

Keywords: Pelvic floor, connective tissue, lower urinary tract symptoms

ÖZET

Ünal, M. (2023). Alt Üriner Sistem Disfonksiyonlu Çocuklarda Konnektif Doku Manipülasyonunun Klinik Semptomlar ve Pelvik Taban Kas Fonksiyonları Üzerine Etkileri.

Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü, Fizyoterapi ve Rehabilitasyon Anabilim Dalı Yüksek Lisans Tezi, İstanbul.

Bu çalışmanın amacı alt üriner sistem disfonksiyonu (AÜSD) olan çocuklarda pelvik taban kas rehabilitasyonu (PTKR)'na ek olarak uygulanan konnektif doku manipulasyonunun (KDM) tek başına uygulanan PTKR'ye göre AÜSD semptomları, pelvik taban kas (PTK) aktivasyonu, üroflovmetri ve mesane günlüğü parametreleri ve yaşam kalitesi üzerine etkilerini karşılaştırmaktı. Çalışmaya AÜSD olan 40 çocuk dahil edildi. Çocuklar blok randomizasyon ile PTKR+KDM (n:20)(PTG) ve PTKR (n:20) (CDG) olarak ikiye ayrıldı. PTKR ve KDM haftada 3 gün toplamda 8 hafta uygulandı. Üroflovmetri parametreleri EMG-Üroflov ile, PTK aktivasyonu Myoplus Pro4 cihazi ile, rezidü idrar miktarı (PVR) ultrasonografi ile, mesane fonksiyonları mesane günlüğü ile, semptom şiddeti Disfonksiyonel İşeme ve İnkontinans Skorlama Sistemi (DİİSS) ile, yaşam kalitesi ise Çocuk Kontinans Spesifik Pediatrik Yaşam Kalitesi Ölçeği (PinQ) ile değerlendirildi. Tüm değerlendirmeler uygulama öncesi ve sonrası gerçekleştirildi. Uygulama sonrası her iki grupta da semptomlarda azalma, üroflovmetri, PVR ve mesane günlüğü parametrelerinde düzelme, PTK aktivasyon değerlerinde ve yaşam kalitesinde gelişmeler görüldü ($p<0,05$). Gruplar arası karşılaştırmalarda CDG'de DIISS skorunda PTG'ye daha fazla azalma, üroflovmetrideki QAve ve mesane günlüğündeki işeme volümünde ve PTK'nın ortalama kasılma aktivasyonunda daha fazla artma ve Pin-Q anketinde daha fazla azalma gösterildi. Bildiğimiz kadarıyla çalışmamız AÜSD olan çocuklarda PTKR ve CTM'yi birlikte kullanıp karşılaştıran tek çalışmadır. Sonuç olarak PTKR hem tek başına hem CTM ile birlikte uygulandığında semptomlar, üroflovmetri ve mesane günlüğü parametreleri, PTK aktivasyonu ve yaşam kalitesi üzerine etkili bir yöntemdir. Fakat CTM ile birlikte uygulandığında semptom skoru, bazı üroflovmetri ve mesane günlüğü parametreleri, PTK kasılma aktivasyonu ve yaşam kalitesinin iyileşmesinde daha etkili olmaktadır. CTM, AÜSD olan çocuklarda yan etkisi olmayan, efektif bir yöntem olarak tercih edilebilir.

Anahtar Kelimeler: Pelvik taban, konnektif doku, alt üriner sistem semptomlar

1. INTRODUCTION AND PURPOSE

Lower urinary tract dysfuntions (LUTD) is an inclusive term that refers to dysfunctions that occur during the filling and voiding phases of micturition. According to the current standardization of the International Children's Continence Society (ICCS), LUTD refers to a condition that occurs with symptoms such as urinary incontinence, urgency, nocturia, hesitancy, dysuria, and weak stream of urination without any uropathy or neuropathy (1). According to epidemiological studies, the prevalence of LUTD in school-age children reaches 20% (2). LUTD in children can develop due to many different factors. It is known that wrong toilet habits acquired during the toilet training period are a cause (3). In addition, it is known that daytime incontinence is associated with age, gender, family history, constipation, urinary tract infection (UTI), emotional stress, attention deficit and hyperactivity disorder (ADHD), while nocturnal enuresis (NE) is associated with gender, family and emotional factors (4).

Today, there are pharmacological and surgical methods in the treatment of LUTD, as well as different approaches such as standard and specific urotherapy and physiotherapy and rehabilitation approaches (5–7). Due to their ease of application and minimal risks, conservative approaches such as bladder training, changing lifestyle and eating habits, pelvic floor muscle rehabilitation (PFMR), electrotherapy, and pharmacological treatment come to the fore.

PFMR is a method used for problems such as urinary and fecal incontinence, overactive bladder, bowel and bladder dysfunction, pelvic pain, pelvic organ prolapse and sexual dysfunctions. This method can also be preferred in the treatment of children with LUTD including family education and motivation, manual therapy techniques, pelvic floor muscle (PFM) exercises, electrotherapy, biofeedback, and functional exercises (8). PFM plays an important role in the storage and voiding functions of the lower urinary tract. In addition, it is known that PFM dysfunctions are involved in the pathophysiology of LUTD (5). When clinical studies in the literature are examined, it has been shown that PFM exercises are used in the treatment of children with LUTD and successful results are obtained (9–12). PFMR is an accessible, non-invasive, and improvable method, and positive results can be obtained in reducing and eliminating the symptoms of children with LUTD.

Connective tissue manipulation (CTM) may also be included in the physiotherapy and rehabilitation approaches that can be applied to bladder symptoms and urological problems. CTM is a reflex treatment technique applied manually to the skin area by physiotherapists. In this method, a shear force is created between dermis-hypodermis or skin-underlying fascia. In addition, angular force is applied to the collagen fibers in order to create a reflex and mechanical effect (13). Although its mechanism of action has not been fully elucidated, it is known that it reduces organ dysfunctions by maintaining the balance between the parasympathetic and sympathetic components of the autonomic nervous system through segmental and supra-segmental cutaneo-visseral reflex pathways (14). CTM applied in addition to PFMR in the pediatric population may play a role in reducing or eliminating LUTD symptoms by restoring the autonomic nervous system balance and increasing vascularity on the bladder. There are a few studies in the literature where CTM has been used in adult bladder and bowel problems, primary dysmonea and climacteric symptoms, but there are no studies applied to the pediatric population without neurological problems (15–18).

The aim of this study is to compare the effects of CTM, applied in addition to PFMR for 8 weeks, on LUTD symptoms, PFM activation, uroflowmetry parameters and quality of life, compared to PTMR applied alone, in children with LUTD.

Hypothesis 0 (H0): In children with LUTD, CTM applied in addition to PFMR has no greater effect on LUTD symptoms than PFMR alone.

Hypothesis 1 (H1): In children with LUTD, CTM applied in addition to PFMR has a greater effect on LUTD symptoms than PFMR alone.

Hypothesis 2 (H2): In children with LUTD, CTM applied in addition to PFMR has no greater effect on PFM activation and uroflowmetry parameters than PFMR alone.

Hypothesis 3 (H3): In children with LUTD, CTM applied in addition to PFMR has a greater effect on PFM activation and uroflowmetry parameters than PFMR alone.

2. THEORETICAL INFORMATION AND LITERATURE

2.1. Lower Urinary Tract Anatomy

The primary roles of the lower urinary tract are to store and regularly elimination urine from the body. The brain and spinal cord center a sophisticated neural control system that regulates these functions. The neural control system acts aki to a basic switching circuit, ensuring a balanced relationship between the bladder (reservoir) and the urethra and urethral sphincter (outlet) components of the urinary tract (19). The storage and evacuation of urine in the bladder is provided by the coordinated work of the detrusor muscle and trigone. In females, the lower urinary tract (LUT) consists of the bladder, urethra and pelvic diaphragm while in males, it includes the bladder, urethra, pelvic diaphragm and prostate. Distinct differences in sexual functions and pelvic anatomy give rise to considerable variation in the LUT anatomy between the sexes (20).

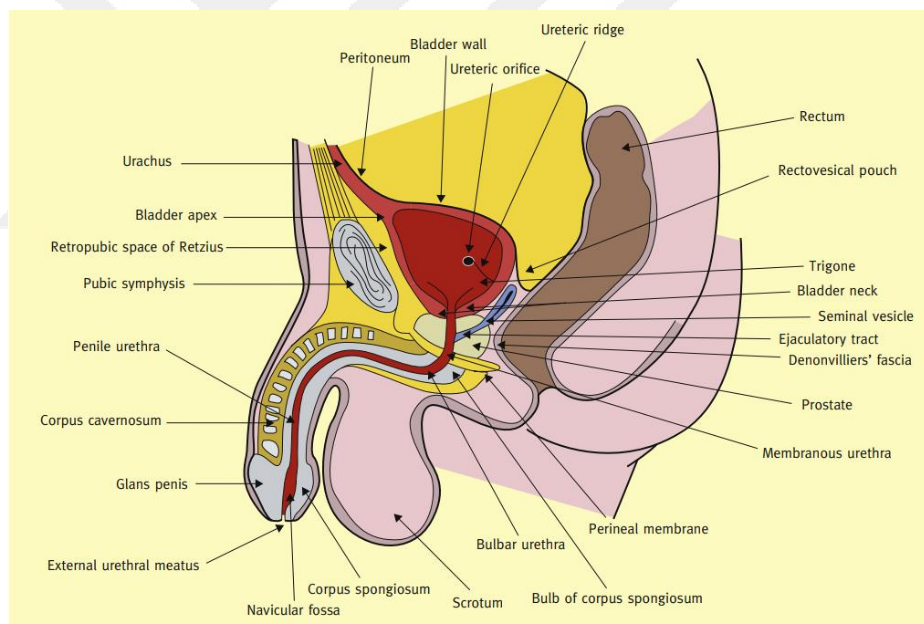


Figure 2.1. Median Sagittal Section of Male Pelvis Showing LUT(20).

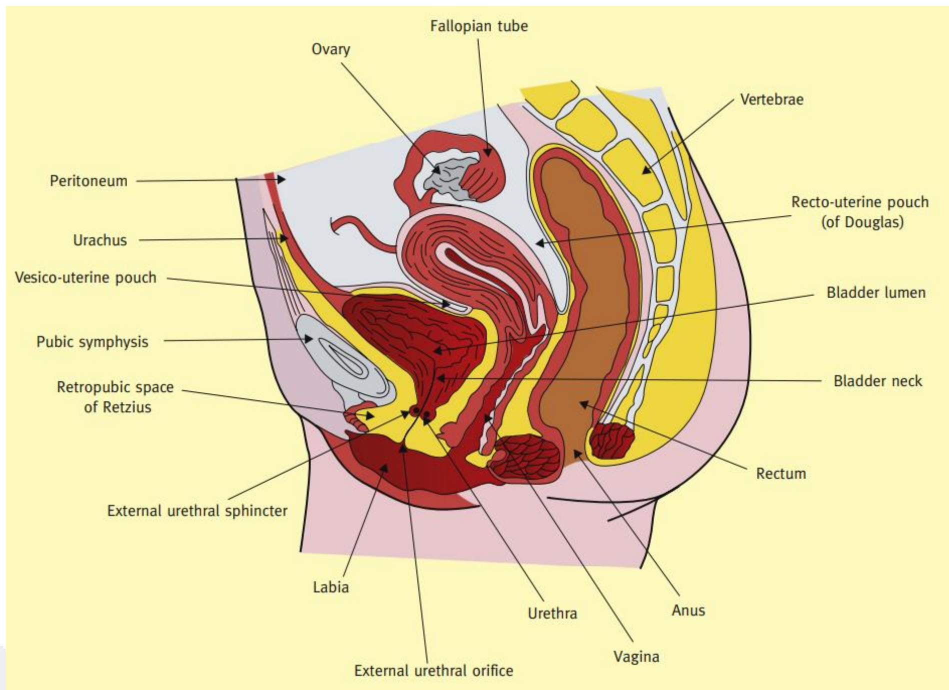


Figure 2.2. Median Sagittal Section of Female Pelvis Showing LUT (20).

2.1.1. Bladder Anatomy

The bladder is an extraperitoneal organ that can contract and is covered by the endopelvic fascia. It consists of epithelial tissue surrounded by smooth muscle and is hollow. Urine coming from the ureters is kept in the bladder and then this urine is transmitted to the urethra. The bladder has an inverted triangle shape and is divided into three parts, the fundus (base), apex (top), and neck. The size, shape, position, and adjacents of the bladder change according to the amount of urine it contains and the condition of the adjacent organs (20). In infants and young children, the bladder is in the abdominal cavity even when it is empty. Also it can be palpated when the bladder is full. This is because the pelvis is not deep at this age. The bladder usually settles in the pelvis by the age of 6 years. However, its complete penetration into the pelvis minor occurs at the end of puberty. In an adult, the empty bladder is located in the pelvis minor. As the bladder fills with urine, it moves upward and ascends into the pelvis majör (21).

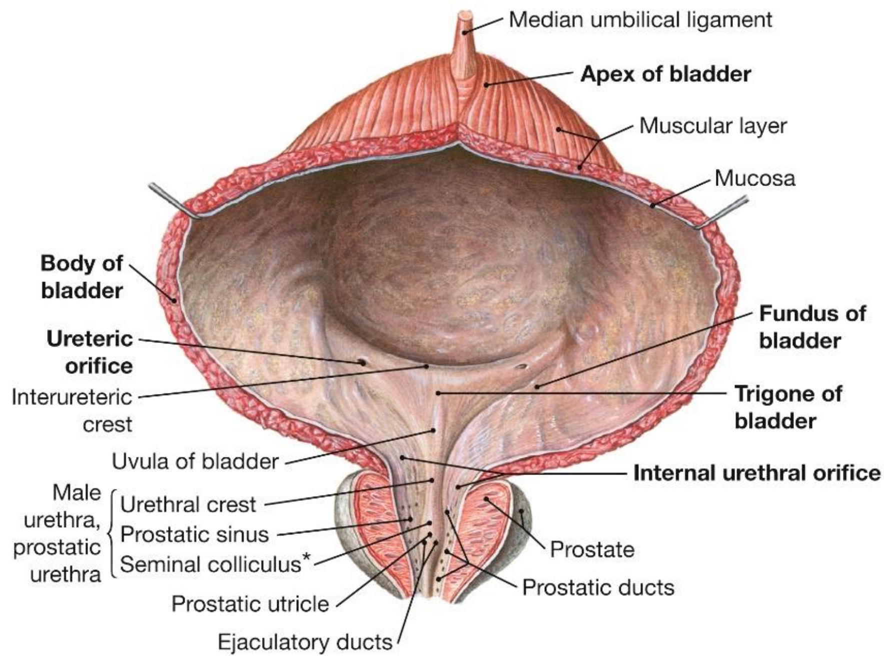


Figure 2.3. Urinary Bladder Male (22).

The bladder is composed of an apex, a base, and superior, as well as two inferolateral surfaces. Anteriorly, the apex surface of the triangular pyramid points to the upper border of the symphysis pubis. The superior surface of the bladder is covered with the peritoneum. On its surface are the small intestine and sigmoid colon. The lowest part of the bladder, where the inferolateral surfaces meet the base, is the bladder neck. In men, the bladder neck is directly above the prostate, while in women, the bladder neck and urethra are located in the connecting tissue of the anterior vaginal wall. The small triangular area on the posterior wall of the bladder just above the bladder neck is called the trigone. While the trigon is fixed horizontally during filling, it changes shape vertically and takes the shape of a cone with the contraction of the detrusor during urination. This change in shape ensures that the bladder outlet is closed during filling and opened during voiding. Therefore, normal emptying of the bladder occurs with contraction of the detrusor muscle, the opening of the bladder neck (internal sphincter), and relaxation of the pelvic floor (striated external sphincter) (23).

The blood supply to the bladder is provided by the superior vesical artery coming from the umbilical artery and the inferior vesical artery coming from the internal iliac artery. Bladder veins drain into the internal iliac vein. The lymphatic drainage of the bladder is to the external and internal iliac lymph nodes (24).

Ligaments of the Bladder: The bladder is connected to the pelvic side wall by the endopelvic fascia, which is reinforced anteriorly by muscular fibers known as the pubovesical ligaments. In males, the bladder neck is secured in place by the puboprostatic ligaments. The rectovesical ligaments extend from the bladder base to the lateral rectum. Furthermore, the median umbilical ligament (urachal remnant), a fibromuscular cord, connects the bladder to the umbilicus. This ligament has a broad attachment that gradually narrows as it approaches the umbilicus. The bladder also exhibits three false ligaments, which are folds within the peritoneum running anteriorly. These include the middle and two lateral umbilical folds, which are formed by the peritoneum covering the remains of the urachus (median umbilical ligament) and the obliterated hypogastric arteries, respectively (20).

Bladder Capacity: Bladder capacity varies according to the age of children. If the child is older than 12 years, the expected bladder capacity (EBC) is considered to be 390 ml. In children younger than 12 years old, bladder capacity is calculated with different formulas.

The recommended formula for infants up to one year of age is the Holmdahl formula (25).

Holmdahl Formula: = [age (month) x 2.5] + 38

Formulas used for EBC in children older than one year are Hjalmas formula (1976) and Koff's formula (1983) (26,27).

Hjalmas Formula = [age (year) x 30] + 30

Koff's Formula = [age (year) + 2] x 30

The maximum voided volume (MVV) refers to the largest amount of urine expelled during voiding, as recorded on the frequency volume chart over a 24-hour period. The inclusion of the first-morning void in the MVV) measurement can vary. Therefore, it is advisable to make a note regarding whether the first-morning void is included or excluded during the investigation of MVV. MVV is considered small if it is less than 65% of the EBC, and more than 150% is large, respectively, excluding first-morning voiding (1).

2.1.2. Urethra Anatomy

The structure that connects the bladder with the outside is the urethra. In both males and females, the urethra serves as a conduit, connecting the urinary bladder to the

external environment to facilitate the passage of urine. In females, the external urethral opening is located in the vestibule of the vagina, whereas in males, it is positioned at the tip of the glans penis. The female urethra functions solely as a passage for urine, whereas in males, the urethra serves as a shared pathway for both urine and seminal fluid. The male urethra, measuring approximately 20 cm in length, can be divided into the pelvic urethra, consisting of prostatic and membranous sections, and the penile urethra, which includes the bulbar portion. The prostatic urethra originates at the bladder neck and is situated within the prostate. Typically, it measures around 3 cm in length and is the widest and most flexible segment of the urethra. On the other hand, the membranous urethra is located within the urogenital diaphragm and is surrounded by the sphincter urethra muscle. It is the least expandable portion of the urethra (28,29).

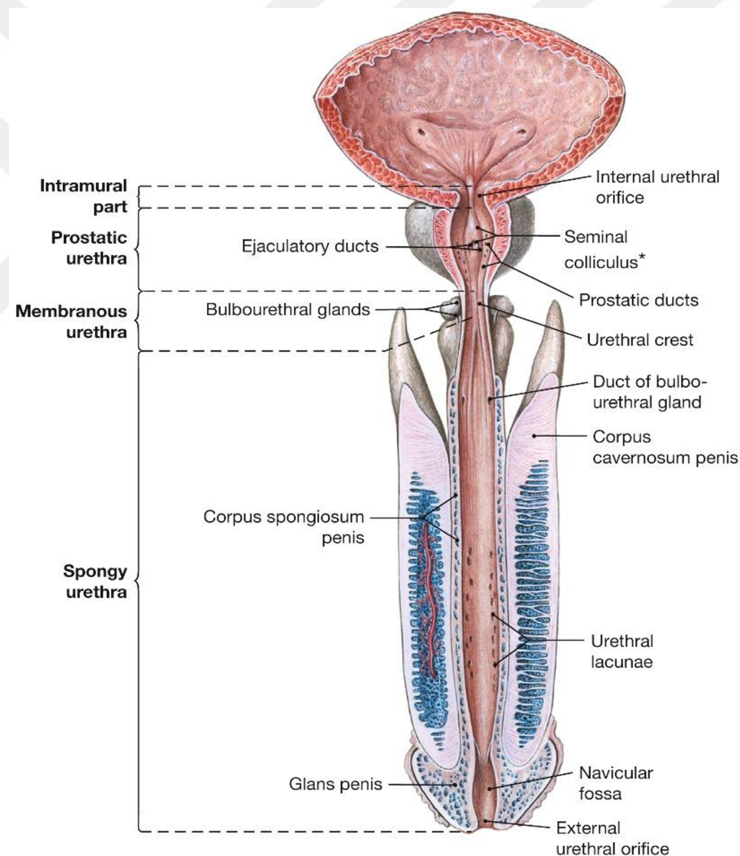


Figure 2.4. Urinary Bladder and Male Urethra (22).

In females, the urethra is approximately 4 cm long and passes under the symphysis pubis and is embedded in the anterior vaginal wall. It starts from the bladder neck and extends to the outer opening of the urethra, located between the labia minora, above the vaginal entrance, approximately 2.5 cm below the clitoris.

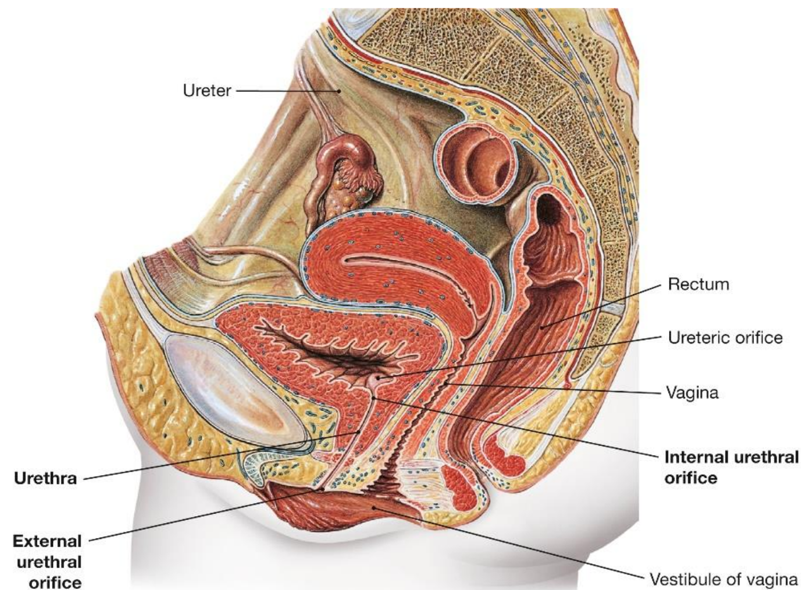


Fıgure 2.5. Female Pelvis and Urethra (22).

The urethra is surrounded by internal and external urethral sphincters, which play a role in storing and expelling urine from the bladder.

Internal Urethral Sphincter: The internal urethral sphincter, a continuation of the detrusor muscle, is a smooth muscle found in the bladder neck and proximal urethra. It is not under voluntary control. It consists of two separate muscle layers, longitudinal and circular.

External Urethral Sphincter: The external urethral sphincter, which is under voluntary control, is a circular striated muscle. It contains both slow-twitch and fast-twitch muscle fibers. It can relax voluntarily to ensure the excretion of urine from the bladder. In cases where abdominal pressure increases such as coughing, laughing, sneezing, it can contract reflexively to prevent incontinence.

2.1.3. Pelvic Floor Anatomy

Pelvic floor is a structure made up of muscles, connective tissue, nerves and vessels. It comprises several elements positioned between the peritoneum and the skin of the vulva. These components, from top to bottom, include the peritoneum, pelvic viscera, and endopelvic fascia, levator ani muscles, perineal membrane, and superficial genital muscles (30). This soft tissue structure is surrounded by the bony structure of the pelvis, consisting of the ilium, ischium, and pubis that articulate with the sacrum posteriorly and anteriorly. The pelvis consists of 3 joints, the sacroiliac joints symphysis pubis. The pelvic

floor is a domed structure made up of striated muscles, which envelop the bladder, uterus, and rectum. Traditional distinction has anterior, middle, and posterior components. It plays a crucial role, along with the anal sphincters, in controlling the storage and elimination of urine and stool (31). In addition, preventing the prolapse of the pelvic organs, ensuring continence, facilitating micturition and defecation, sexual function, and undertaking the task of straining during labor can be counted among the most important functions of the pelvic floor.

2.1.3.1 Bone Structure and Ligaments

Pelvis; It consists of the ilium, ischium, pubis, sacrum, and coccyx bones (32). Ilium, Ischium, Pubis are called "Os Coxae". The ilium is the largest of these, forming the upper part of Os Coxae. The pubis is the smallest of these, forming the lower-anterior-inner part of Os coxae. The ischium is the strongest of the three bones, forming the lower-posterior part of the Os coxae. The sacrum is a large triangular bone that forms the posterior part of the pelvic cavity. There can be significant differences in the shape of the sacrum between individuals, as well as structural differences between the left and right sides. The coccyx is the continuation and endpoint of the vertebral column.

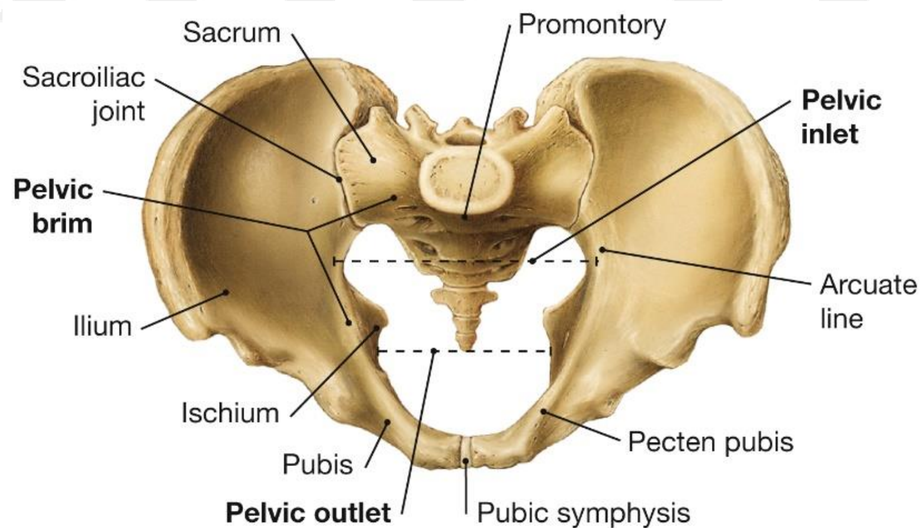


Figure 2.6. Pelvis; Superior View (22).

The pelvis is divided by the iliopectineal line above into pelvis major and pelvis minor. The pelvis major contains the descending, ascending and sigmoid colon and small intestine. Pelvis minor includes the bladder, reproductive organs, rectum, and small intestine folds. The main joints of the pelvis are articulatio sacroiliaca and symphysis

pubica. Although artciculatio lumbosacralis and sacrococcygea are attached to the axial skeleton, they are directly related to the pelvis (21).

2.1.3.2 Endopelvic Fascia

The endopelvic fascia connects the cervix and vagina to the pelvic walls. It is located on both sides of the pelvis and consists of collagen, elastin and smooth muscle fibers. The main ligaments of fascia, which is a fibromuscular tissue, are the cardinal (transverse cervical) and uterosacral ligaments. This structure is not under stress when the levator ani muscles are working normally.

2.1.3.3 Pelvic Floor Muscles (PFM)

PFM is divided into 3 as superficial, middle and deep layers.

A. Superficial Layer

- *Bulbospongiosus Muscle:* Supports the corpus perineale and pelvic floor in men and women. In men, the bulbus compresses the penis, allowing the last drop of urine and semen to be expelled. It also helps with erection. In women, it helps the erection of the clitoris and compresses the grandula vestibularis major. Nerve is N. Pudendus (21).

- *Ischıocavernosus Muscle:* It compresses the veins in men and women. Thus, it provides an erection in men by pushing blood from the root of the penis to the corpus penis. In women, it provides an erection by pushing blood from the clitoris root to the clitoris. Nerve is N. Pudendus (21).

- *Transversus Perinei Superficialis Msucle:* These band-shaped muscle, which attach to the tuber ischiadicum and ramus ossis ischial, extend medially to the centrum perineum in the midline. Supports and fixes the corpus perineale/pelvic floor to support the abdominopelvic organs and increase intra-abdominal pressure. Nerve is N. Pudendus (21).

- *External Anal Sphincter Muscle:* Surrounding the anal canal, this muscle consists of skeletal muscle. It consists of deep, superficial and subcutaneous parts from top to bottom. The deep part surrounds the uppermost part of the anal canal and merges with the fibers of the levator ani muscle. The superficial part also surrounds the anal canal, but is attached anteriorly to the centrum perineum, posteriorly to the coccyx and ligamentum anocoxygeum. The subcutaneous part covers the anal opening just under the skin. This

muscle closes the anus, pulls the anal canal forward, and relaxes during defecation. Its nerve is the N. Rectalis inferior (33).

B. Middle Layer

- Urethral Sphincter Muscle: It is a muscle with upper and lower parts. While the upper group fibers surround the lower part of the urethra, the lower group fibers start from the ligamentum transversum perinei and progress backwards, wrapping the urethra from both sides. It has the function of narrowing the urethra. Its nerve is Nn. Perinealis, a branch of N. Pudendus.

- Transversus Perinei Profundus Muscle: It is a muscle located in the second floor of the perineum and stretches thin, flat, and transversely. On both lateral sides, the ramus ossis begins on the inner surface of the ischial and ends at the centrum tendineum perinei. This muscle, which forms almost the entirety of the urogenital diaphragm, stabilizes the position of the corpus perineale. Its nerve is Nn. Perinealis, a branch of N. Pudendus.

- ***Compressor Urethra Muscle:*** It originates from the ischiopubic rami and its fibers extend anteriorly and fuse with the contralateral side in front of the urethra. It works as the auxiliary sphincter of the urethra and closes the urethra. Its nerve is Nn. Perinealis, a branch of N. Pudendus.

- Uretrovaginal Sphincter Muscle: Its fibrils originate from the corpus perineale and pass lateral to the vagina and converge on the opposite side in front of the urethra. The muscle, which can also help close the vagina, basically works as the auxiliary sphincter of the urethra.

C. Deep Layer

The levator ani muscle and the coccygeal muscle in the deep layer form the pelvic diaphragm. Pelvic diaphragm muscles are connected on peripherally to the pubic body and ischial spine, as well as to the arcus tendineus, which is a thickening of the obturator fascia located between these regions (31).

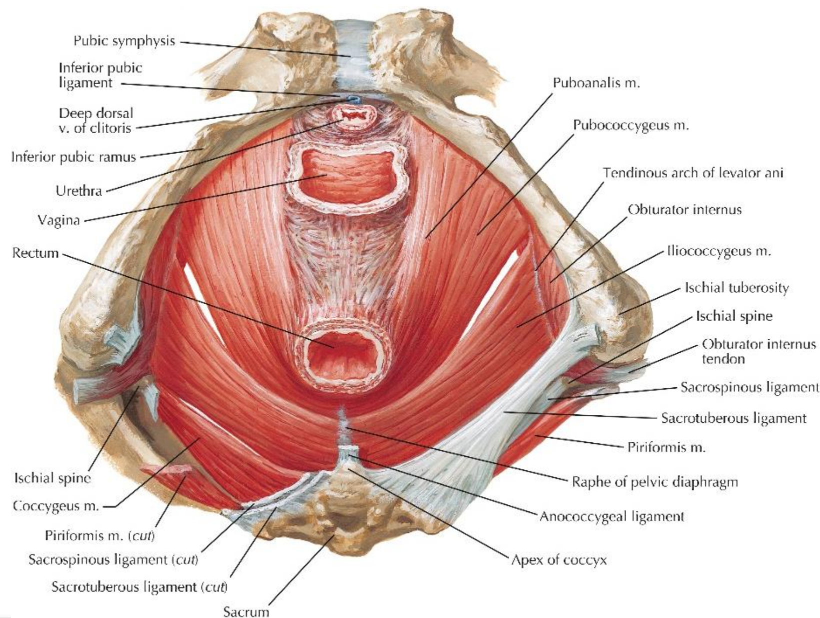


Figure 2.7. **Pelvic Diaphragm (Female); Inferior View (34).**

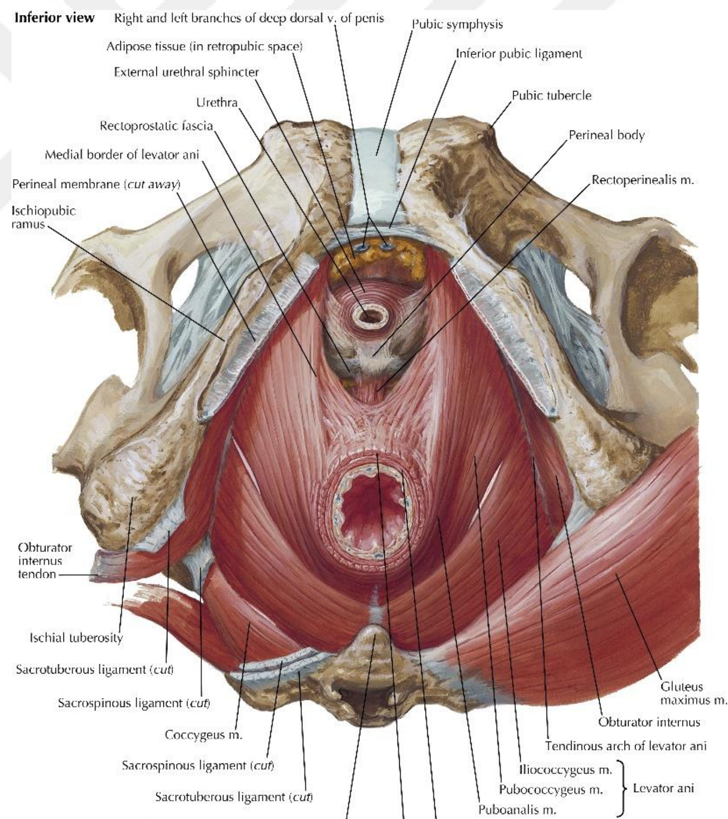


Figure 2.8. Pelvic Diaphragm (Male); Inferior View (34).

a) Levator Ani Muscle

It stretches between the pubis anteriorly, the coccyx posteriorly, and the lateral walls of the pelvis, forming the floor of the pelvis. The levator ani muscle anchors the

vesical neck, anorectal junction, and vaginal fornices to the side wall of the pelvis using the suspensory sling and hiatal ligament. It supports the abdominal and pelvic organs, facilitates micturition and defecation, maintains urinary-fecal continence and provides lumbopelvic stability. In addition, this muscle group plays a role in pelvic organ fixation, evacuation, sexual performance, erection and ejaculation, defecation and pelvic floor disorders (35). The levator Ani includes the pubococcygeus, puborectalis, and iliococcygeus muscles innervated by the sacral nerve roots (S3-S5).

- ***Pubococcygeus Muscle:*** Pubococcygeus is at the most anteriorly. It enters the coccyx from the posterior surface of the two pubic bones. According to the attachment regions of the muscle fibers, it is divided into three parts puboperinealis, pubovaginalis, and puboanalis. The origin of this muscle is the posterior pubic bone and arcus tendineus. Its insertion is the anococcygeus ligament and coccyx. Its function is to maintain the floor tone in the upright position (32).

- ***Puborectalis Muscle:*** The puborectalis muscle lies beneath the pubococcygeus. This muscle creates a U-shaped sling around the rectum. Its sphincter-like function pulls the anorectal junction forward, thereby assisting in maintaining continence (32). Defecation occurs with partly voluntary and partly reflex action of both smooth and striated sphincters and relaxation of the puborectalis (36).

- ***Iıiococcygeus Muscle:*** It is located posterior to the levator ani complex. Its origin is ischial spine and arcus tendineu and its insertion is anococcygeal raphe and coccyx. It is the thinnest part of the levator ani muscle. Its function is voluntary control of urination (32).

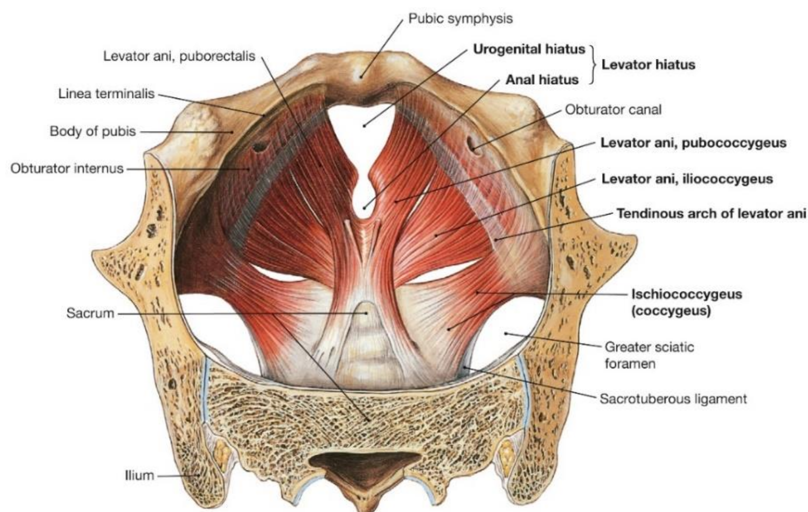


Figure 2.9. Pelvic Floor Muscles (Female); Superior View (34).

b) Coccygeal Muscle

The two coccygeal muscles are triangular and lie above the ligamentum sacrospinale. Its origins are ischial spine and its insertions are lower sacral and upper coccygeal bones. It has functions such as supporting the pelvic organs and stabilizing the sacroiliac joint. Its nerves are the 4th and 5th sacral spinal nerves. This muscles rupture during childbirth can cause pelvic organ prolapses (32).

2.1.3.4 Physiology of the Pelvic Floor

PFM function is provided by contraction and relaxation. The pelvic floor provides support to the pelvic organs. Active support is provided by muscle contraction, while passive support is provided by fascia and connective tissue. With an increase in intraabdominal pressure, the PFM contracts, and the perineum moves ventrally and cranially. As a result, the pelvic organs move upwards through the levator ani. When the PFM contracts, the anus, vagina, and urethra close. This is very important in the prevention of urinary and fecal incontinence. The International Continence Society has defined "normal pelvic floor muscles". According to this definition, normal pelvic floor muscles should be able to contract voluntarily and involuntarily with sufficient strength, and should also be able to relax completely (37). Voluntary contraction is the on-demand contraction of the PFM. Voluntary relaxation is the ability of the muscle to relax on demand after this contraction. Involuntary contraction means the contraction of the PFM in order to prevent incontinence when the intra-abdominal pressure increases. Involuntary relaxation occurs with straining and Valsavra maneuvers.

With the contraction of the bladder and relaxation of the urethral sphincter, micturition occurs. The PFM (especially the pubococcygeus part of the levator ani muscle) also relaxes voluntarily during this time. This coordination is necessary to ensure voluntary voiding and continence. During defecation, the anal sphincter and puborectalis muscles relax simultaneously, leading to the opening of the rectoanal angle and allowing the passage of feces. Anal sphincter relaxation is a reflexive action primarily regulated by the parasympathetic division of the autonomic nervous system. On the other hand, the PFM and abdominal muscles are under voluntary control, enabling defecation to occur at a socially appropriate time and place, similar to urination (36).

2.1.4 Development of Urinary Control

Anatomical, physiological, biological, psychological and sociocultural factors play a role in the developmental process of urine control. Children typically achieve stable bladder control between the ages of 3 to 6 years, first during the daytime and later extending to nighttime as well. By the age of 7, approximately 10% of children continue to experience bedwetting, and during the day, around 2% to 9% may still be affected (38).

The physiological development of bladder control is divided into four phases. The first stage covers newborns and the first 6 months of life. During this period, urination occurs frequently (average 20 times a day) and reflexively. In the first few days of life after birth, micturition is very rare. The first micturition can occur after 12 to 24 hours. After the first week, the frequency increases rapidly. At 2 to 4 weeks of age, it can rise to 24 per day. Then it decreases and after 6 months, the urine in the newborn bladder occurs frequently with reflex contractions of the detrusor, approximately 10-20 repetitions per day. The second phase covers the sixth and twelfth months of life. In this stage, the frequency of voiding decreases and the volume of urine begins to increase with the inhibitory effect of the central nervous system. The third stage is the period when bladder filling begins to be felt between the ages of one and two years. In this phase, the number of voiding decreases. Also, this phase is the phase in which the ability to delay voiding begins to be acquired by increasing the suppression of bladder contractions with central nervous system inhibitions. The fourth stage is the period between the third and fourth years, when the control of voiding becomes stronger with inhibition mechanisms. The ability to voluntarily initiate voiding is also acquired at this stage. On average, five-year-olds have an adult-type voiding pattern and stay dry both during the day and at night (39,40). In conclusion; urinary continence develops by increasing bladder capacity, learning the voluntary control of the periurethral striated muscle sphincter, and providing voluntary control of the spinal micturition reflex. Although it varies according to cultural and individual factors, typical bladder and bowel control development is as follows;

- night (nocturnal) bowel control,
- daytime bowel control
- daytime bladder control
- night (nocturnal) bladder control

2.1.5 Normal Micturition Mechanism

Achieving full control of micturition is a complex process that requires behavioral maturation as well as anatomical, physiological and neurological maturation. The process of excreting urine, which is formed in the renal collecting ducts, consists of two phases. Initially, there's the storage phase, where the urinary bladder acts as a reservoir to accumulate urine. Then, the voiding phase commences once the bladder reaches a threshold volume of urine. Both the storage and voiding phases are regulated by reflex mechanisms involving the autonomic and somatic nervous systems. Supraspinal central nervous system input mechanisms also play a role in influencing the process of micturition (41). The storage phase of the bladder is mediated by norepinephrine under the control of sympathetic nerves. The voiding phase is mediated by acetylcholine under the control of parasympathetic nerves. The voiding phase first begins with relaxation of the urethral sphincter. This is followed by contraction of the bladder, increase in bladder pressure and urine flow within a few seconds. During voiding, the bladder base, bladder neck, and proximal urethra relax together. Secondary reflexes that occur during the flow of urine from the urethra also facilitate the emptying of the bladder (42). Before starting to void, the individual must voluntarily relax their perineal muscles. These perineal muscles;

- Levator ani
- Bulbospongioz Muscle (in men)
- Urethral sphincter and compressor urethra

After the completion of voiding, the following muscles contract voluntarily;

- Ischiocavernous
- Bulbospongioz
- external sphincter

The process of micturition is regulated by a spinal-brainstem-spinal system. As the bladder fills, stretch-sensitive mechanoreceptors in the bladder wall become active. Neurons in the lateral sacral cord receive information about bladder filling. Information about bladder filling is transmitted to neurons in the lateral sacral cord, and these neurons, in turn, relay this information to the central parts of the periaqueductal gray (PAG). When it becomes necessary to initiate micturition, various cell groups in the dorsomedial and particularly the lateral PAG activate the pontine micturition center. PAG constantly

receives information about bladder filling, its decision to initiate micturition is heavily influenced by the limbic system and prefrontal cortex, which continuously assess the safety of the environment (43). Urination is accomplished through the transmission of micturition reflex signals to the detrusor muscle and relaxation of the external sphincter by the efferent autonomic fibers arising from the spinal cord. In order for urination to be successful, the central nervous system and the urinary system must work in harmony, and they must develop in accordance with physiological steps. Any disruption in these steps affects lower urinary tract function.

2.2. Lower Urinary Tract Dysfunction (LUTD)

ICCS published a standardization article in 2016 that includes the current terms LUTD in pediatrics (1). In 2018, an updated article was published by the European Society of Pediatric Radiology in order to create a common language between pediatric nephrologists and pediatric urologists (44). By definition, LUTD is without significant uropathy or neuropathy; increased or decreased frequency of voiding, urinary incontinence, urgency (urgent need to void), getting up to urinate at night (nocturia), delay in starting voiding when the child is ready to void (hesitancy), burning or discomfort during voiding (dysuria), and urination in a weak stream is a condition that manifests itself with different symptoms (1,45). Briefly, LUTD is a broad term that covers bladder symptoms during the storage and voiding phases of urine. Although it is common among children, a study has shown that the prevalence of LUTD in school-age children is 7-10% and reaches 20% (2).

Since LUTD is a comprehensive term, it can be related to many different factors. It is known that daytime urinary incontinence is associated with age, gender, family history, constipation, UTI, emotional stress, attention deficit and ADHD, NE and inadequate toilet facilities in children. NE is related to gender, family factors, emotional factors, childhood factors, culture and time. The prevalence of NE decreases with age. (4).

2.2.1. Lower Urinary Tract Symptoms

According to the standardization article prepared by ICCS in 2016, lower urinary system symptoms are divided into 3 main titles as storage phase, voiding phase and other symptoms (1).

Storage Symptoms

- **Incontinence**

Urinary incontinence (UI) is described as involuntary urinary incontinence. UI can be continuous or intermittent. Incontinence also has subtitles such as daytime incontinence and enuresis. It is defined as continuous incontinence, constant urinary incontinence during the day and night, usually associated with congenital malformations. Problems such as congenital malformations, vesicovaginal fistula or loss of function of external urethral sphincter may cause continuous incontinence. Intermittent incontinence, which is divided into two subheadings as daytime incontinence and enuresis, is defined as urinary incontinence in discrete amounts. When it occurs during the child's sleep period it is called enuresis, while when it occurs while awake it is called daytime incontinence (1,45).

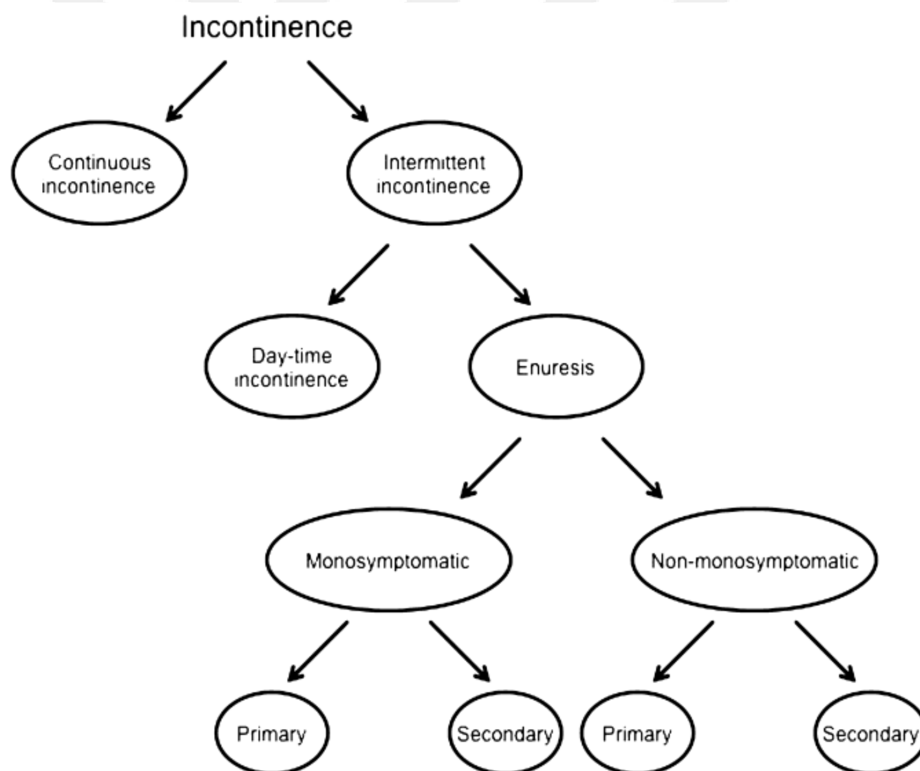


Figure 2.10. Subtypes of Incontinence (Taken from ICCS 2016 Standardization)

- **Decreased or Increased Voiding Frequency**

The frequency of voiding is a variable parameter and is more affected by age, fluid intake and diuresis than it is affected by bladder capacity. Studies show differences in terms of voiding frequency. According to the ICCS's guideline, 8 or more urinations per

day is defined as "increased voiding frequency", while 3 or fewer urinations per day is defined as "decreased voiding frequency". A bladder diary containing voiding frequency/volume should be collected to fully understand voiding frequency (1,45).

- **Nocturia**

Common among schoolchildren, nocturia is defined as waking up at night with the desire to urinate. Unlike enuresis, nocturia does not result in incontinence. Also, nocturia does not always indicate LUTD or a pathological condition. It is not used for children who wake up for reasons other than the need to urinate.

- **Urgency**

It refers to the sudden, unexpected need to urinate. This term, which is used after bladder control is achieved, generally refers to bladder overactivity.

Voiding Symptoms

- **Hesitancy**

This term means that when the child is ready to urinate, he/she has difficulty initiating urination.

- **Weak Stream**

It refers to making urine with a weak stream.

- **Dysuria**

This term refers to the discomfort and burning sensation during urination. Dysuria at the beginning of voiding indicates that the pain originates from the urethra, while dysuria that occurs after voiding may be caused by the bladder.

- **Straining**

This term refers to the child's increased intra-abdominal pressure by exerting a great effort of effort to initiate and maintain voiding. The Valsavra maneuver can be given as an example.

- **Intermittency**

In this symptom, voiding does not occur continuously. During voiding, there are several different episodes of stopping and restarting.

Other Symptoms

- **Holding Maneuvers**

They are methods used to suppress urgency or delay voiding that may be associated with bladder overactivity. These are movements that can be easily observed from the outside, whether the child is aware of doing these maneuvers consciously or not. The most observed behaviors include crossing the legs, grasping the genitals or abdomen, standing on tiptoes, and squatting with pressure on the perineum.

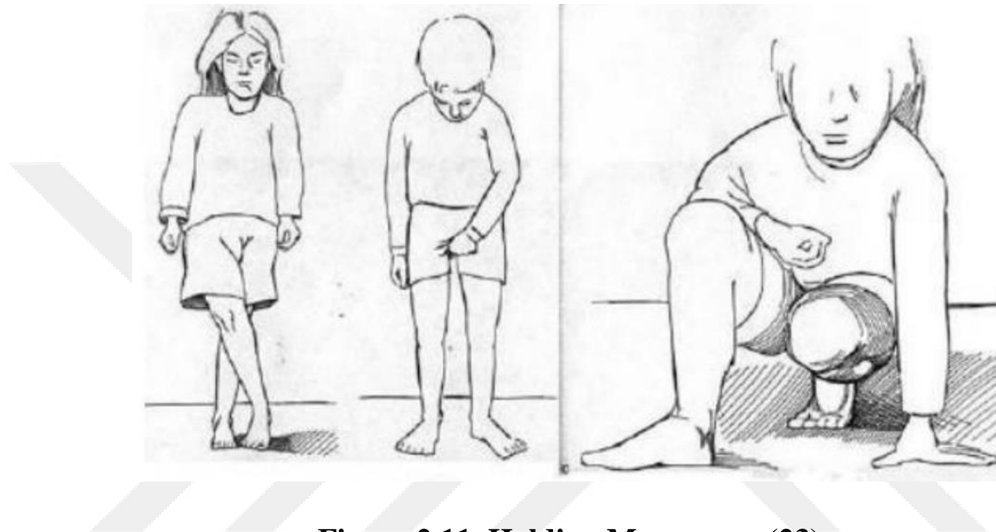


Figure 2.11. Holding Maneuvers (23)

- **Urinary Retention**

In this symptom, the child feels the fullness of the bladder but has the feeling of not being able to void despite persistent effort.

- **Feeling of Incomplete Emptying**

The child with this symptom does not feel the bladder empty after voiding and needs to return to the toilet to void again. Young children may not be able to fully express this symptom.

- **Spraying (Splitting)**

It defines the urine coming out as a spray or as a split instead of a single and uninterrupted stream. This symptom usually indicates mechanical obstruction at or just below the meatus.

- **Post Micturition Dribble**

It refers to the involuntary dripping of urine after voiding. Urinary incontinence due to vaginal reflux may present with this symptom.

- **LUT and Genital Pain**

Since LUT pains cannot be precisely localized in childhood, it is difficult to define by the patient.

2.2.2. Lower Urinary Tract Dysfunction Classification

Classification of LUT conditions is complex due to heterogeneity and convergence of conditions, and borderline cases are common. The ICCS recommends evaluation and documentation according to 5 items to provide a framework for classifying daytime LUTD findings;

- Incontinence (presence/absence and frequency of symptoms)
- Frequency of voiding
- Urgency to void
- Voiding volume
- Fluid intake

It is stated that the assestment of these 5 parameters is more important than classifying the various subgroups listed below.

- **Bladder and Bowel Dysfunction (BBD)**

It describes the situation in which bladder and bowel disorders occur together. In the absence of any comorbid bowel dysfunction, the term LUTD alone is sufficient. The true incidence of BBD is unknown. The close interaction between the bladder and bowel is an important factor (46). The reference point for LUT symptoms is 5 years of age. The minimum age for functional bowel dysfunction is 4 years. Severe BBD is associated with LUT and bowel dysfunction in children without neurological abnormalities. When severe BBD also begins to cause problems in the upper urinary tract (e.g,vesicoureteral refluand/or), it may be synonymous with Hinman's Syndrome (1).

- **Dysfunctional Voiding (DV)**

DV refers to the inability of the sphincter or pelvic floor muscles to relax during voiding. There is no disorder in the storage phase, it is related to the voiding phase. When

electromyographic measurment (EMG) activation is examined during voiding, a staccato pattern is seen. The term DI is used in patients who do not have any neurological problems. It is a picture that occurs as a result of inappropriate voluntary contraction of the pelvic floor muscles and external sphincter during voiding, and the detrusor extrinsic sphincter not working in harmony. During voiding, the pelvic floor muscles cannot relax enough, but the child tries to increase the detrusor pressure by using the anterior abdominal wall muscles. Thus, the duration of urine flow increases, and the flow rate increases. This increases the risk of vesicoureteral reflux, urinary tract infection, and urinary stasis by causing both an increase in intravesical pressure and residual urine. Especially during the toilet training period, wrong practices reveal dysfunctional voiding disorder(47).

- **Overactive Bladder (OAB)**

It refers to urinary urgency, usually accompanied by frequency and nocturia, in the absence of a significant pathology and/or urinary tract infection. It is the most common voiding disorder especially in children aged 5-15 years and affects girls more. Holding maneuvers such as crossing the legs and squatting are common. OAB diagnosis can be made in children over the age of 5 who have been toilet trained. Many potential risk factors are unclear but thought to be multifactorial (48). The diagnosis of detrusor overactivity, which is usually seen in children with OAB, can only be made by cystometric evaluation. In addition, one of the most common symptoms in children with OAB is urgency incontinence, which is associated with urgency. In children with OAB, positive activity can be detected in EMG as a result of the contraction of the pelvic floor muscles to suppress the sudden feeling of urgency and incontinence.

- **Underactive Bladder (UAB)**

The child with this pathology increases intra-abdominal pressure to initiate, maintain and/or complete voiding. Straining symptom is observed. Also known as lazy bladder. In children with UAB, an interrupted pattern is usually observed in uroflowmetry. In addition, when urodynamic evaluation is made, detrusor underactivity is mostly found. Residual urine, low voiding frequency, urge or overflow incontinencce, susceptibility to UTI and episodes of hesitancy are common symptoms with these children. In these children, the uroflow flow model is plateau-shaped; but in this case, it

should be differentiated from bladder outlet obstruction. Pressure flow studies are used to differentiate (1,49).

- **Voiding Postponement**

It is the habit of children to delay urination with holding maneuvers. The clinical history of this behavior is usually associated with decreased voiding frequency, incontinence from a full bladder and a sense of urgency. Some of these children have also learned to restrict fluids, thereby reducing incontinence. When diagnosing these patients, it should be kept in mind that psychological comorbidities and behavioral disorders may accompany as well as good clinical observation (1).

- **Stress Incontinence**

It refers to the occurrence of a small amount of involuntary urinary incontinence in case of increased intra-abdominal pressure for any reason (coughing, sneezing, etc.). It is rarely seen in childhood.

- **Bladder Outlet Obstruction**

It is the obstruction of urine output due to mechanical or functional, static or phasic reasons. It is characterized by increased detrusor pressure and decreased urine flow rate.

- **Giggle Incontinence**

This rare condition describes the complete emptying of urine in the bladder, which occurs during giggling or laughing and is more common in girls. Bladder functions are normal in these children in the absence of laughter.

- **Vaginal Reflux**

This condition, which occurs due to labial adhesions or inappropriate positions during voiding and is observed only in girls, is defined as post-void dripping. It is usually seen in obese girls. It is not associated with lower urinary tract symptoms.

- **Extraordinary Daytime Only Urinary Frequency**

It describes toilet-trained children who micturition in small amounts during the day and needs to micturition frequently. These children do not have nocturnia and incontinence is rare. Urination occurs at least once per hour and is less than 50% (usually 10-15%) of expected bladder capacity.

- **Bladder Neck Dysfunction**

Impaired/delayed opening of the bladder neck resulting in decreased urine flow despite adequate or increased detrusor contraction.

- **Enuresis**

It is one of the types of intermittent incontinence and refers to the situation in which incontinence occurs while sleeping. It covers children aged 5 and over who wet the bed at night. Enuresis is divided into primary and secondary. If the patient has not been dry for more than 6 months until the time of diagnosis, it is called "primary enuresis". If it has remained dry for at least 6 months, it is defined as "secondary enuresis". But more clinically significant is the "monosymptomatic" and “non-monosymptomatic” grouping of enuresis. The absence of any accompanying symptoms of LUT (except nocturia) and bladder dysfunction is defined as monosymptomatic enuresis (MNE). However, if there is a LUT symptom accompanying enuresis, it is defined as non-monosymptomatic enuresis (NMNE) (50). It is thought that developmental delay defects, sleep-related factors, abnormalities in the secretion of Antidiuretic Hormone and nocturnal urine formation, genetic causes, behavioral causes, and neurological and psychological causes may be the etiology of MNE. It has been suggested that three interrelated factors such as nocturnal polyuria, decreased functional bladder capacity and difficulty in awakening play a role in the development of enuresis in relation to these reasons. It is thought that enuresis occurs with the effect of these three different pathophysiological mechanisms individually or together (23).

2.3. Lower Urinary Tract Neurophysiology

The bladder is innervated by nerves from the autonomic and somatic systems. From the autonomic system, the sympathetic are T1-L2 and the parasympathetic are S2-S4. Somatics are the nerves coming from S2-S3 and S4 via the pudendal nerve or by means other than the pudendal nerve. Parasympathetic nerves are located in the sacral region and relax the urethra while the bladder contracts. Lumbar sympathetic nerves relax the bladder while contracting the bladder neck and urethra. The pudendal nerve provides contraction of the urethra.

2.3.1. Autonomic Nervous System

Efferent and Afferent Parasympathetic Pathways

Sacral parasympathetic motor activity is responsible for the main excitatory stimulation of the bladder. Cholinergic preganglionic neurons localized in the sacral intermediolateral region send axons to ganglia in the pelvic plexus and bladder wall via pelvic nerves. Conduction in the bladder ganglia is provided by the nicotinic cholinergic mechanism. Ganglion cells; stimulates bladder smooth muscle through cholinergic (acetylcholine) and noncholinergic-nonadrenergic transmitters (adenosine triphosphate). Postganglionic transmission in the bladder is controlled presynaptically by the release of acetylcholine (Ach). The afferent branch of the parasympathetic pathway originates from the S2-S4 dorsal root ganglia. These neurons are bipolar and send messages to the bladder smooth muscle and epithelium as well as the urethra. They carry the mechanical stimuli (feeling of tension and fullness) of the lower urinary tract. These mechanoceptive stimuli are responsible for the initiation of voiding (51).

Efferent and Afferent Sympathetic Pathways

Sympathetic preganglionic pathways originating from T11-L2 spinal segments terminate in short adrenergic neurons in the bladder and urethra. The sympathetic nervous system exerts its effects through alpha and beta adrenergic receptors. Alpha receptors are predominantly located in the bladder trigone and proximal urethra, while beta receptors are located in the bladder fundus. Alpha-adrenergic stimulation causes contraction in the trigone and proximal urethra. Beta adrenergic stimulation provides relaxation of the detrusor muscle. In addition to these effects, the sympathetic system suppresses detrusor contractions by inhibiting parasympathetic conduction with spinal reflexes (51).

In summary; the sympathetic system regulates the storage phase by causing detrusor relaxation and proximal urethral contraction. The parasympathetic system regulates the voiding phase by causing detrusor contraction and relaxation of the urethra. The sympathetic afferent pathway is localized in T11-L2 dorsal root ganglia. They transmit pain, touch and heat impulses of the lower urinary tract.

2.3.2. Somatic Nervous System

Motor fibers

The pudendal nerve originating from the pudendal nucleus at S2-4 level in the spinal cord is the motor nerve innervating the external sphincter.

Sensory fibers

Pelvic nerves originating from the S2-3 segment contain sensory and motor fibers. Sensory fibers are under the influence of the parasympathetic system. Sensory fibers transmit bladder wall tension (23).

2.4. Lower Urinary Tract Dysfunction Assestment

Detailed evaluation is very important in the correct diagnosis and treatment of children and adolescents with LUT dysfunction. Physical examination and comprehensive history are diagnostic tools in the evaluation. According to the ICCS, the child's holding maneuvers, movements that indicate a sense of urgency, and behavioral problems should be observed during the assessment. Evaluation tools methods are divided into invasive and non-invasive (1). It is essential that patients presenting with voiding disorder symptoms in recent years should be evaluated primarily with noninvasive methods.

2.4.1. History

History is an essential step in evaluation and should be specific. Information on both the child and the parent/caregiver should be included. While taking the history, the child's developmental stages from birth should be evaluated and the family history of enuresis or incontinence should be investigated (52).

Regarding urination; conditions such as voiding pattern, urine flow, amount of urine, frequency, urgency, urge incontinence, urinary retention, dripping, intermittent urination, and inability to urinate adequately should be questioned (1).

Detailed information on when (day, night, both day and night), where (school, home, community areas), how severe (small or large volume), how often (week or day) urinary incontinance occurs and when it started must be acquired. The age at which the child was toilet trained, surgical history, family history, medications and allergies, bowel habits, and presence of urinary tract infection should be recorded. In addition to these, school performance and behavior in friends and family should also be examined (52). In the literature, the relationship between attention deficit and hyperactivity disorder and enuresis, as well as the relationship between dysfunctional elimination syndrome and sensory processing disorder has been shown (53,54). In addition, there may be voiding

postponement and urge incontinence in high-achieving children who focus too much on school success and lessons (52). For these reasons, it is important for clinicians to evaluate the child's behavioral and emotional characteristics.

2.4.2. Physical Exam

A detailed physical examination should be performed in all children with LUTD. First of all, the vital signs of the patients should be evaluated; height and weight should be recorded (24).

In these children, the physical examination includes abdominal, genital, and lumbosacral evaluation. Abdominal stiffness, presence of trigger points and tenderness are assessed by palpation. A bulging sigmoid or descending colon is an important sign of the presence of constipation (55).

In genital examination; findings such as labial fusion and clitoromegaly in girls, phimosis, epispadias, hypospadias, and bilateral undescended testicles, and micro orchitis in boys should not be overlooked. Evaluation of perineal reflexes, perineal sensation and anal tone provides information about neurological integrity. Since walking and muscle strength of the lower extremities are neurologically important, they must be included in the evaluation (42). Hip, leg asymmetries or foot deformities should not be overlooked.

The presence of symptoms such as subcutaneous lipoma, skin discoloration, a tuft of hair, epidermal atrophy, and hemangioma in the lumbosacral region is evaluated. Abnormal hair growth, presence of gluteal asymmetry and abnormal color change suggest an underlying neurological pathology (55). In the first examination, further examinations such as urinalysis, urine culture, ultrasonography, magnetic resonance imaging are planned, taking into account the physical examination findings.

2.4.3. Urinalysis

Urinalysis should be performed to identify any glucosuria or infection. Urinary tract infections can cause transient incontinence by causing intravesical inflammation and irritation. If there are symptoms such as frequent urination, bad odor and color change in the urine, and burning during urination in the patient's history, it should be kept

in mind that there may be an infection. Patients with glucosuria and ketonuria in urinalysis should be investigated for Diabetes Mellitus (42,56).

2.4.4. Ultrasound Imaging

Urinary system ultrasound is a simple, easy to apply, and non-invasive imaging method. With this method, kidney dimensions, bladder wall thickness, parenchyma thicknesses, anteroposterior pelvis diameters, proximal and distal ureter diameters, also pre and post-void residual urine volume can be measured (42).

Post-void residual urine (PVR) is evaluated by transabdominal ultrasound. The PVR should be checked within 5 minutes after the child has voided. According to ICCS, it is significant in children aged 4-6 years when PVR is 30 ml and above, while it is significant when PVR is above 20 ml in the 7-12 age group. Due to the high variability of PVR tests, repeat testing is required when the initial PVR is high (1,4,45).

Bladder wall thickness (BWT) can be done when the bladder is full or empty. Normal BWT should be less than 3 mm when the bladder is full and less than 5 mm when empty. Increased BWT may be associated with detrusor overactivity or neurologic bladder. Decreased thickness may be associated with insufficient activity of the detrusor muscle (57,58).

2.4.5. Urine Flow Measurement

Uroflowmetry is a common, easy-to-perform and non-invasive test to evaluate LUT function. Uroflowmetry is indicated in toilet trained children with symptoms of LUT and UTI. Although there are no contraindications, these tests are usually not performed if the child has an acute illness or an active UTI. In this evaluation method, parameters such as flow curve shape, voided urine volume, maximum and average urinary flow rate, and voiding time are obtained. In this diagnostic test, the patient is asked to urinate into a reservoir connected to the computer system. It measures the urine flow rate in ml/sec (4,59). For the test to be reliable, the child must urinate at least 50% of the expected bladder capacity for her/his age. Before the test, the child should drink enough water. The amount of fluid required 1 hour before the test is equal to the expected bladder capacity (EBC).

Uroflovmetry test is also used in combination with EMG. Thus, synergy or weakness between the bladder and the pelvic floor-sphincter complex can be evaluated.

It is used to show the pelvic floor muscle activity with the voiding pattern of the patients (60). However, perianal surface EMG may be affected by artifact, not reflecting urinary sphincter activation (4).

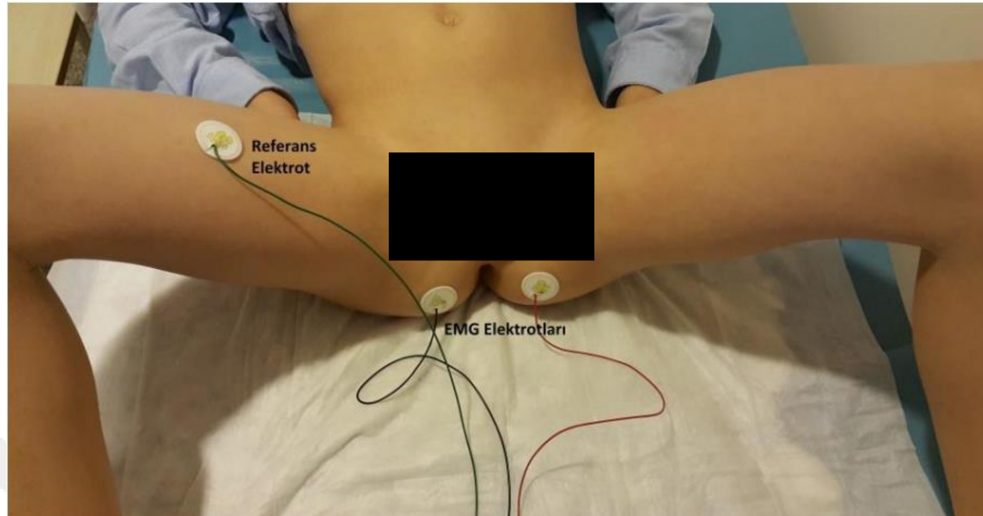


Figure 2.12. Placement of Electrodes in Uroflowmetry.

(Photograph taken from Prof. Dr. Halil Tuğtepe's Personal Archive with his permission.)

Parameters Used in Uroflowmetry:

- Voided Urine Volume: The volume of urine that the patient voids during the test (ml)
- Maximum flow rate (Qmax) : It is the highest flow value measured during the entire flow period.
- Voiding time: Total duration of urine flow, including interruptions. If there is no interruption, voiding time and flow time give the same result.
- Flow time: It is the time when there is only urine flow.
- Average flow rate (Q_{ave}) : It is obtained by dividing the voided urine volume by the flow time.
- Time to maximum flow: It is the time from the beginning of the flow to the moment it reaches its maximum.

Uroflowmetry Flow Curve Shapes

According to ICCS, there are 5 different flow patterns. The shape of the flow is very important in analyzing the flow pattern. However, not every specific pattern

conclusively points to an underlying diagnostic abnormality. It can guide the existence of a specific condition.

- **Bell-shaped curve:** A normal uroflowmetry curve should be in a healthy child. (regardless of age, gender and voiding volume)

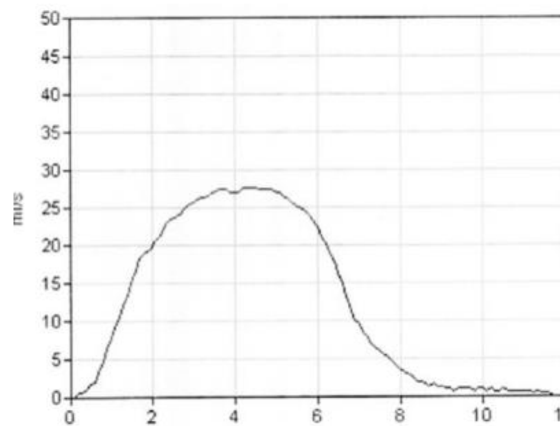


Figure 2.13. Bell-Shaped Curve (1).

- **Tower-shaped curve:** It is a high-amplitude, short-term, and rapidly developing curve. It suggests an OAB.

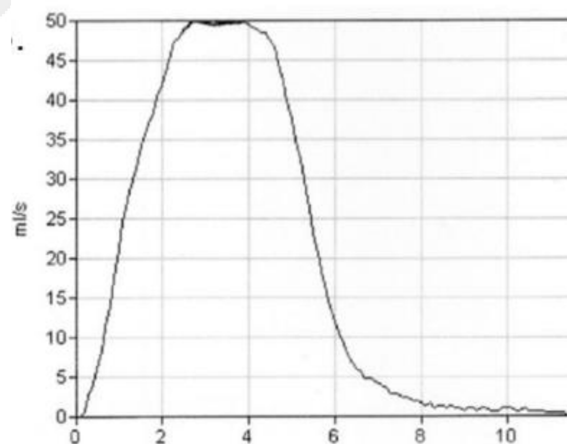


Figure 2.14. Tower-Shaped Curve (1)

- **Staccato-shaped curve:** It is an irregular and fluctuating flow pattern throughout voiding, but never reaches zero during voiding. This curve is often associated with DV due to the incoordination between the bladder and sphincter. To call it a Staccato curve, the fluctuations should be larger than the square root of the maximum flow rate.

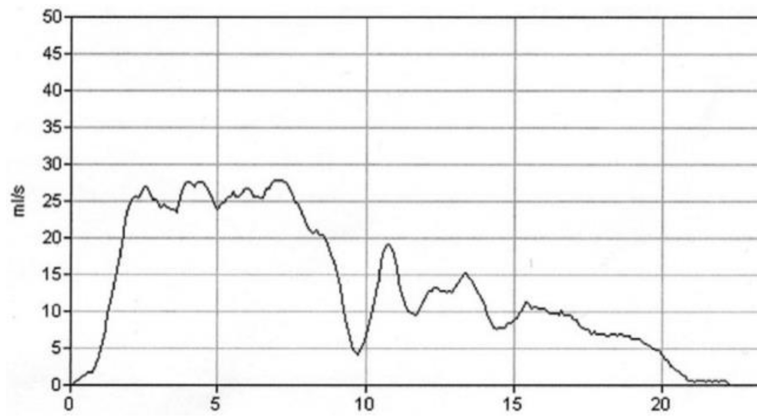


Figure 2.15. Staccato-Shaped Curve (1).

- **Interrupted-shaped curve:** This curve is similar to the staccato voiding curve, but here during voiding the voiding curve intermittently reaches zero. This voiding pattern usually indicates an UAB.

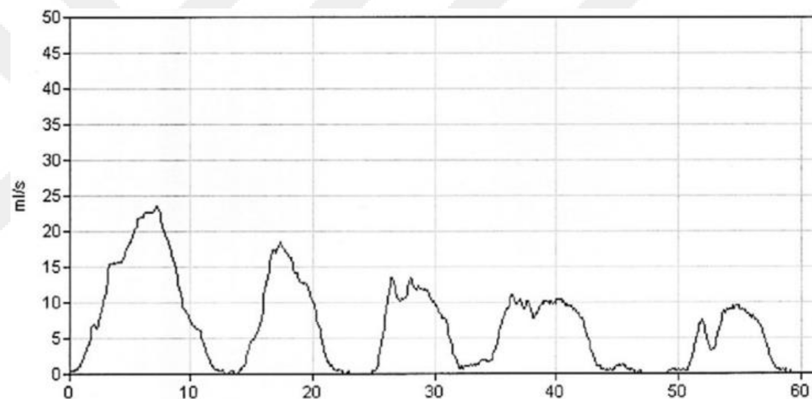


Figure 2.16. Interrupted-Shaped Curve (1).

- **Plateau-shaped curve:** It is a low amplitude, long duration and flattened voiding curve. It can be caused by anatomical or dynamic reasons**.**

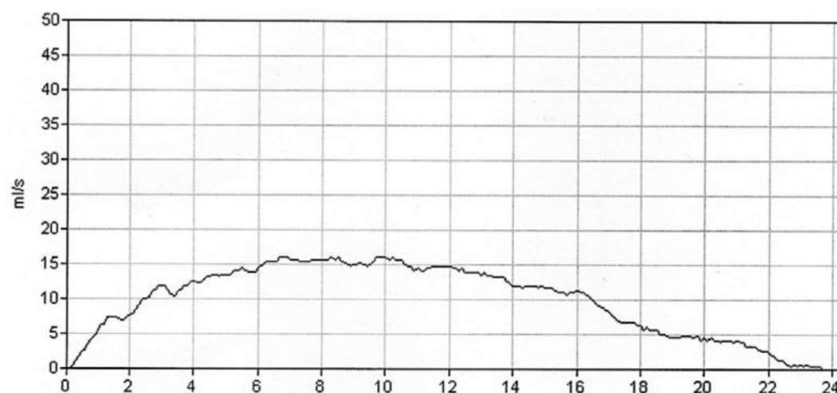


Figure 2.17. Plateau-Shaped Curve (1).

2.4.6. Bladder Diary

It is an easily accessible, objective and non-invasive method used to evaluate LUTD. According to the ICCS, a bladder diary of at least 48 hours should be kept for the evaluation of children with LUTD. With this diary, the child's daytime voiding frequency and volume, the amount and type of fluid taken can be recorded. Evaluating the sense of urgency experienced during the day, it provides information about daily functional bladder capacity. It can be used for diagnostic and therapeutic purposes. Also 7 nocturnal episodes of incontinence should be recorded for children with enuresis and overnight urine volumes should be measured. (1,61).

Because of the close relationship between bladder and bowel function, both systems should be evaluated together. The Bristol stool scale and 7-day bowel diary used for recording should be preferred. The most widely accepted guideline for diagnosis in children with a controversial diagnosis of functional constipation is the Rome-IV criteria (1).

2.4.7. Invasive Urodynamics

Urodynamics is a neuro-urological diagnostic method for revealing and measuring physiological and pathological factors related to the storage, voiding and transport of urine. Currently, urodynamic studies are not routinely used in children with LUTD, but are used when neurogenic bladder is suspected. Urodynamic studies evaluate the bladder, bladder neck, and urethra (1).

2.4.8. LUT Function Questionnaires

Many tests are available to use as assessment tools. However, there are few questionnaires with validity and reliability. The questionnaires with validity and reliability in Turkish are explained below.

Dysfunctional Voiding and Incontinence Scoring System (DVISS): It is a questionnaire that evaluates the severity of LUTD and is completed by parents. It was developed by Akbal et al in 2005 to be suitable for the pediatric population. There are 13 questions about symptoms and 1 question about quality of life. Akbal et al. when the quality of life question was excluded from the scoring, found the specificity and sensitivity of the scoring to be 90% in those who scored 8.5 and above. As the score obtained from the scale increases, the severity of the symptoms also increases (62).

Pediatric Urinary Incontinence Quality of Life Score (PIN-Q) : Bower et al. developed the PinQ scale in 2005 for use in children with urinary incontinence. The Turkish validity and reliability of the questionnaire was conducted by Hanımeli R. in 2011. The questions are read to the children one by one and the answers are recorded by the person reading the questionnaire. In studies, it was stated that children completed the questionnaire in 5 to 15 minutes. Each question is given a score of 0 (no), 1 (almost never), 2 (sometimes), 3 (often), 4 (always), and a total score (0-80) is calculated. An increase in the total score indicates that the patient's quality of life worsens (63).

2.4.9. Pelvic Floor Assestment

Bladder control is achieved by inhibiting the detrusor muscle and activating the striated-smooth pelvic floor sphincter muscles. There is a relationship between neuromotor control of the pelvic floor and urinary control. PFM needs to function normally during both storage and voiding phases of urine (64). Pelvic floor structures, perineal reflexes, perineal sensation evaluations should be included in the physiotherapy evaluation by making arrangements to be suitable for the pediatric population. PFM functions, activation and strength are also important parameters that should be evaluated pretreatment and posttreatment in PFM rehabilitation.

Pelvic floor assessment can begin with visual observation of the perineum. Thus, color change in the perineum, edema, lesions, atrophic tissues and the resting position of the perineal region can be recorded. Bulbocavernous, anal bulbospongiosus reflexes, and extra cremester reflex in boys can be evaluated to provide information about the neurological status (65).

EMG, a non-invasive and practical technique, can be used to evaluate PFM activation. It has been stated that it is appropriate to evaluate PFM activation using the surface electrode in children (66). In a study, it was found that PFM activation was less in children with MNE than in the healthy control group (64). According to the European Biofeedback Federation, if the EMG value is below 2 mV while the PFM is in a resting state, this is within the normal limits. However, the EMG value is affected by factors such as age, genetic structure, presence of neurological problems, location, and size of the electrodes. For these reasons, there is no standard mV value required to ensure continence. The disadvantage of superficial EMG is that it can cause artefacts. However, this can be avoided by taking precautions before the measuremen (9). Observation of

PFM activation on EMG and staccato voiding pattern in uroflow during voiding are effective for the diagnosis of DI. There is a relationship between short PFM EMG lag time and detrusor overactivity in urodynamic results in children with OAM.

PFM function can be evaluated from the external anal sphincter in children. Properties of PFM such as voluntary contraction and relaxation, involuntary contraction and relaxation are evaluated and PFM function is divided into 4 subgroups. These are “overactive”, “underactive”, “normal” and “nonfunctional” groups (37).

PFM strength can be evaluated in children by palpation from the external anal sphincter and using the Modified Oxford system. It is evaluated out of 0 and 3+ in children. Values of 4 and 5 are not used in the pediatric population because they require internal palpation.

2.5. Lower Urinary Tract Dysfunctions Treatment

2.5.1. Urotherapy

Urotherapy is a broad term that was developed in the 1980s by Anna-Lena Hellström and Marianne Vijverberg, aimed at improving and relieving the symptoms of LUTD. It is defined by the ICCS as "a non-surgical, non-pharmacological, conservative treatment of LUTD symptoms”. Urotherapy should be performed by a healthcare professional. Although it varies from country to country, people working in fields such as nursing, physiotherapy, medicine or psychology can become urotherapy specialists (67). The ICCS has defined differently "standard urotherapy", which is first-line therapy for most functional disorders, and "specific urotherapy", which requires indication and is effective only for certain LUTD (1).

Standard Urotherapy

It is preferred as the first-line treatment in many functional problems of LUT. Basic 5 principles of standard urotherapy;

- **Information**

It includes providing information about normal LUT function and describing the condition the child has. It begins with an explanation of bladder and bowel functioning. It is important that the explanation and content are age appropriate and motivate the child.

Parents and children should be able to understand the correct LUT functions and make sense of their situation.

- **Instruction**

It refers to a detailed description of how to improve the symptoms of LUT. It includes regular urination and fluid intake times, proper toilet posture, elimination of urinary retention behaviors and ensuring regular bowel habits. The correct toilet position is effective in emptying the bladder and bowel as it will provide relaxation in PFM (5). While buttock support is provided with the toilet seat, the feet can be supported with the toilet stool. When the child sits on the toilet, the soles of the feet should touch the floor so that the knee angle is 90º. The legs should be open to allow the pelvic floor to relax, the back should be straight and slightly bent forward. Before urination, children should be provided to remove their clothes in a way that does not prevent them from opening their legs. For small children, the toilet should be made suitable for the child with toilet adapters and foot supports. Otherwise, the child, who cannot balance on the toilet, will unconsciously contract the pelvic floor muscles, causing the external sphincter to contract during voiding and the bladder cannot be completely emptied. It should be explained to the child that he does not rush to urinate, that he needs time to urinate properly and relax (68). With the timed voiding method, voiding and fluid intake times are adjusted according to the child's condition and symptoms. Thus, it is aimed to provide bladder training. Regular voiding can create sensory awareness for the bladder with age-appropriate amounts of urine. It is a part of regular peeing that the child must go to the toilet before going to bed and when he/she wakes up (68). If there are symptoms such as constipation, fecal retention, soiling in the child's history, treatment should be initiated to regain normal bowel habits before starting LUTD treatment.

- **Life-style Advice**

It includes regular and balanced fluid intake, dietary advice, and regular bladder-bowel emptying patterns. Adequate and regular hydration enables the establishment of the bladder's routine storage and voiding cycle. Minimizing holding maneuvers with voiding every 2-3 hours prevents overdistension of the bladder. Additionally, balancing urine concentration through sufficient hydration reduces irritative effects and facilitates rehabilitation (52). Many foods and beverages can cause bladder irritation, which are defined as the 5Cs: Caffeine, carbonation, citrus, chocolate, and coloring (any food or

beverage containing dye or coloring agents). This foods and beverages that cause bladder irritation should not be consumed (42).

- **Registration**

Symptoms and voiding habits are recorded using bladder diaries, charts, and apps. Bladder diaries enhance children's active involvement in the treatment process, increase their motivation, and facilitate treatment adherence.

- **Support and Encouragement**

It includes regular follow-up of the caregiver.

Specific Urotherapy

It includes biofeedback, alarm therapy, intermittent catheterization and neuromodulation. Approaches applied in addition to urotherapy include psychotherapy and cognitive behavioral therapy (6). Approaches applied in addition to urotherapy include cognitive therapy and psychotherapy. Thus, a psychological problem caused by the LUT symptoms in the child is minimized, and the child's participation and compliance with the treatment is supported (69).

- **Alarm Therapy**

An enuresis alarm is a fluid-sensitive device that usually gives warning with sound and vibration. As soon as urine drips onto the child's clothes or bedding, the detector will operate and an alarm will sound. The success rate of alarm, which is indicated as the first-line treatment in children with enuresis, is between 50 and 70 percent (50). The alarm should be used by well-informed and motivated families and their children. Points to be considered in alarm treatment;

- ✓ Both the child and the family should be shown the device and explained in detail.
- ✓ It should be used every night, should not be interrupted.
- ✓ If the child himself does not wake up when the alarm goes off, he should be awakened by the caregiver.
- ✓ The alarm should be continued until 14 consecutive dry nights are experienced.
- ✓ The health care provider should be contacted 1-3 weeks after the alarm is used.

In the literature, alarm therapy has been shown to be a successful first-line intervention to manage PMNE compared to desmopressin. In alarm therapy, it should be a priority to support the family and the child, and to prefer applications for their motivation (70).

- **Biofeedback**

Biofeedback helps the child understand how to achieve PFM/sphincter contraction and relaxation. Thus, both awareness and voluntary control of the child increase. Before starting biofeedback, the child should have knowledge of PFM function and localization. Children over the age of 5 interact better with biofeedback. The motivation of the child and family is important. Animated, child-directed biofeedback applications help children interact more with treatment. However, there is no difference between the animated and the non-animated ones that affect the result (7). The main purpose of this method is to teach correct voiding and defecation habits by retraining the PFM system and the bladder-brain connection (71). Biofeedback can be combined with interactive computer games. The therapist's experience plays a very important role in the treatment because of the specificity of PFM training (6). In the literature, studies have been conducted showing that biofeedback has positive effects in conditions such as DV, UAB, bladder-bowel dysfunction (BBD), UTI (72). A systematic review reports that biofeedback is an effective method in DI and 80% of children benefit, but the evidence level of the studies is low and more randomized controlled trials (RCT) are needed (73). In a systematic review and meta-analysis published in 2022, it was shown that biofeedback was effective in symptoms such as UTI and constipation, and improved uroflowmetry parameters such as PVR, compared to standard urotherapy. It has also been reported to give better results in the long term effects (74).

- **Neuromodulation**

There are many different types of neurostimulation applications. There are both invasive and non-invasive methods. These are sacral nerve implantation, transcutaneous, ano-genital, endoanal, posterior tibial nerve, and intravesical methods. Sacral nerve implantation is an invasive method and offers positive effects in patients with neurogenic bladder. Non-invasive Transcutaneous electrical nerve stimulation (TENS), applied with superficial electrodes, can be applied from both the posterior tibial nerve (ankle) and the third sacral foramina region for the non-neurogenic LUTD symptoms. The use of surface electrodes from the S3 region has made TENS more applicable in children. Although the

mechanism of this application is not fully understood, there is a hypothesis that the electric current directly affects the central nervous system with the activation of neural structures. With the stimulation applied to the S3 region, the innervation of the bladder, external anal sphincter and bladder is modulated. Thus, coordination of sacral reflexes is ensured (6,67). In the literature, there are studies in which non-invasive TENS application is used in OAB, NMNE, neurogenic bladder and constipation. The total duration of the applications and the results found vary. Clinical changes and improvements reported in these studies include increased bladder capacity, decreased or improved incontinence, decreased UTI frequency, and decreased urgency severity (75).

- **Clean Intermittent Catheterization (CIC)**

It can be preferred in children with UABwho do not benefit from conservative treatments, if there are conditions such as incomplete emptying of urine or urinating by straining. It is recommended in children with significant PVR and urinary retention. Children over 6 years old can do their own catheterization. Self-catheterization is important for the child in terms of independence. CIC is effective, but there is a lack of studies in the literature in neurologically healthy children (67).

2.5.2. Pharmacological Treatment

- **Antimuscarinic Treatment**

These agents, which block M2/M3 receptors in the bladder and suppress bladder contractility, are used especially in OAB and UI patients when standard urotherapy and neuromodulation cannot be effective. Side effects include tachycardia, constipation, blurred vision, dry mouth and flushing. Oxybutynin is the most commonly used antimuscarinic type in the pediatric population (76).

- **Alpha Blockers**

Selective α-adrenergic blocking agents may be an option in patients with treatment-resistant functional bladder outlet obstruction. ICCS does not recommend this group of drugs in the treatment of DV (6).

- **Desmopressin**

This agent, which is an analog of antidiuretic hormone, increases water retention in the body, causing the kidneys to produce less urine at night. As a result, it provides less

urine output than the functional bladder capacity at night. It is particularly used in enuretic children who do not have normal ADH secretion at night (77).

- **Prophylactic Antibiotics**

It is recommended to use prophylactic antibiotics to prevent infections during the primary treatment of cases with LUTD and recurrent UTI (78).

2.5.3. Botulinum Toxin

It is an agent that acts by blocking the release of acetylcholine at the presynaptic cholinergic junction. It is applied cystoscopically by injecting many points in different parts of the detrusor, except for the trigon. Although primarily used for neurogenic detrusor overactivity, it is also used in children with non-neurogenic OAB. Its effect lasts for 6-8 months (68).

2.5.4. Phsiotherapy and Rehabilitation Approaches

In the past, the only physiotherapy and rehabilitation method used for LUTD was biofeedback. In the 2000s, the terminology of biofeedback and PFM training gave way to the term "rehabilitation" in the literature. In the publications made with this concept, studies have been enriched by using different physiotherapy modalities such as urotherapy, TENS, manual assessment, diaphragm breathing exercises, therapeutic exercise approaches (5,10,12). Physiotherapy and rehabilitation approaches used in the treatment of LUT symptoms include PFM training, manual therapy techniques, electrotherapy and exercise.

2.5.4.1. Pelvic Floor Muscle Training

PFM plays an important role in the storage and voiding functions of the lower urinary tract. PFM is known to play a role in the pathophysiology of LUTD. It plays a role in maintaining urethral closure and support continence during the storage phase of urine. To provide urethral support, the medial part of the levator ani muscle, the endopelvic fascia of the anterior vaginal wall, and the arcus tendineous fascia pelvis connection must be intact. During the evacuation of urine, the external urethral sphincter and the levator ani muscle must be relaxed. If these systems do not function properly, LUTD symptoms can occur (79). Today, traditional biofeedback methods have been replaced by pelvic floor physiotherapy in the literature. Biofeedback alone is not

considered an effective treatment without other components of PFM training (8). In 1949, the PFM exercises were introduced by Kegel as the basis (80). Kegel exercises are based on isolated training of the PFM. Nowadays, PFM is considered as a part of the core system and its synergistic effect is shown with the abdominal muscles. Studies The PFM works in coordination with the thoraco/abdomino/pelvic muscles to aid continence, intra-abdominal pressure and gravity support (81,82). Although PFM exercises were first introduced by Wennergren and Oberg in the field of pediatric urology, there is no standardized exercise protocol (11). Thus, PFM training, which was applied for the first time by physiotherapists, has taken its place in the literature as an alternative treatment that can be added to treatment programs because it is non-invasive, entertaining and instructive. Although not a standard protocol, there are studies in which PFM exercises are used in the treatment of symptoms of children with LUTD and positive results are obtained (5,9,12,83).

2.5.4.2. Manuel Therapy Techniques

Manual approaches used in PFMR include massage, stretching, mobilization, manipulation, hold-relax technique and myofascial release. These are special clinical techniques that can be applied by the physiotherapist. It includes approaches applied to the diaphragm, pelvis, abdomen, anal, vaginal, hip and back regions (8,84,85).

In overactive PFM with trigger points, it is aimed to provide relaxation by applying myofascial release techniques to the perineum and surrounding tissues. Joint mobilization and muscle energy techniques are used to restore motion by placing the lumbar spine, pelvic girdle and hip joint in their optimal positions for maximum mobility (86). Although there are more studies using manual therapy techniques in PFMR in the adult population, there are fewer studies in children. Massage techniques, osteopathic approaches, connective tissue manipulation and kinesiotape applications come to the fore in studies conducted in the pediatric population (18,84,87,88).

The aim of osteopathic approaches applied with techniques such as mobilization is to reduce movement limitation and improve postural symmetry. Thus, it is stated that PFM is also positively affected (84). Kinesio taping is a method used to increase blood and lymph flow in local and peripheral areas, relieve pain, improve proprioception and increase muscle strength. It is thought to be effective in reducing symptoms in children with urinary incontinence by improving bladder tone and increasing proprioception, but

more studies are needed (88). Connective tissue manipulation is thought to be effective on both bladder and bowel symptoms by balancing the autonomic nervous system in the internal organs and increasing the circulation in that organ (16,18).

2.5.4.3. Electrotherapy

Electrotherapy is a physiotherapy modality in which electrical energy is used in different frequencies and waveforms for therapeutic benefits. Different electric current can be used for pain relief, nerve and muscle stimulation, muscle strengthening, relief of muscle spasm, improvement of blood flow and wound healing. Electrotherapy modalities can affect sensory and motor functions as well as glandular and secretory functions. There are several types of electrodes and devices used for electrical stimulation (8).

With the development of electrotherapy methods and devices over time, their use in the adult and pediatric population with LUTD has also become widespread. When the literature is examined, it is observed that electrical neural stimulation is frequently used in children with LUTD. The first sacral TENS application for children was performed by Hoebeke et al., and also by Bower et al. These stimulations have applications of posterior tibial nerve, ano-genital, endoanal and sacral implants and there are many studies on them (89). Functional electrical stimulation (FES) is a type of current with therapeutic purposes that stimulates nerve or neuromuscular junctions. It aims to create muscle contraction with these stimuli. When the literature is examined, there are studies in which FES is applied in both adult and pediatric populations (90,91). There are opinions that FES provides continence by developing weak muscles (8). However, in some studies, it is said that it is thought to provide detrusor inhibition indirectly (90). Interferential electrical stimulation is a medium-frequency current that targets deep tissues. This type of stimulation is produced by crossing two different medium frequencies, 4000 Hz currents. It has been used for incontinence, OAB, and PFM strengthening in the female population for over two decades. There are also studies showing that it is an effective method in children with LUTD. Although no major complications have been reported, its effect has been shown to be superior to placebo. New studies are needed to evaluate its long-term effects (92).

Electrical stimulations can be used in LUTD symptoms due to PFM dysfunction. The important point here is PFM function and evaluation. When the studies are examined,

it is observed that there are current types used in different frequencies, wavelengths and durations (93,94).

2.5.4.4. Exercise

Exercise is one of the main units of physiotherapy. It has been demonstrated that there is a synergy between abdominal muscles and PFM. Pelvic floor, transversus abdominus, diaphragm and multifidus muscles work together to form the "core" system. These deep core muscles are a component of the local stabilization system that plays an important role in the lumbopelvic region (95). The diaphragm, our main respiratory muscle, forms the top of the abdomino-pelvic cavity, while the PFM forms its floor. These two muscle structures, which have a concave-convex relationship in opposite directions, are connected to each other by the transversalis fascia. The transversalis fascia is also connected to the transversus abdominis muscles and is continuous with the diaphragmatic fascia above and the pelvic fascia below (96). In their study, Talas et al. showed that the PFM moves parallel to the diaphragm in the craniocaudal direction during respiration (97). In a 2015 study, it was shown that PFM exercises are more effective when combined with abdominal and diaphragmatic breathing (DB) exercises in the treatment of urinary incontinence (98). In a study conducted in 2022, no difference was found between the group in which DB exercises and PFM exercises were applied, and it was stated that DB could be an alternative to PFM exercises (96). DP exercises are also used in children with LUTD as an effective method that is simple and easy to teach (10).

Past studies show that urinary incontinence can cause changes in movement patterns during physical activities. For this reason, exercises to improve function and fitness can also be preferred in people with LUTD (8). Today, the concept of "functional exercise" comes to the fore. With functional exercises, it is aimed to improve the strength, mobility, balance and coordination of the primary and auxiliary muscles that provide continence. In a study of 48 children with non-neuropathic bladder dysfunction, game-based core stabilization exercises were shown to be effective in the DVISS score. Again, in the same study, better results were revealed in the uroflowmetry parameters in the group in which game-based core stabilization exercises and biofeedback were performed together compared to the other groups (99). In recent studies, children with nocturnal enuresis have been shown to have balance and posture problems when compared with

control groups. Children with NE in this study were observed to have more forward inclination of pelvis and worse balance abilities (100). In addition, another study showed that children with constipation problems had decreased trunk control and impaired posture compared to control groups (101). When these relationships are interpreted, it is observed that functional exercises such as motor control, balance and core stability can be applied to support treatment in children with LUTD. These exercises also increase motivation by providing variety. Today, as an alternative to classical exercises, exercises with auxiliary materials such as fitball are thought to be more preferable in long-term treatment (102). In another similar study, it is thought that squat, bridge and fitball exercises help strengthen the muscles and ligaments of children with daytime/nighttime enuresis (103).

2.6. Connective Tissue Manipulation

Connective tissue manipulation (CTM) is a reflex treatment technique applied manually to the skin area by physiotherapists. This technique was developed in 1928 by the German physiotherapist E. Dicke. One of Dicke's lower extremities had peripheral circulatory dysfunction (endarteritis obliterans) and the decision to amputate was made. There was also severe pain in Dicke's lower back. As a result of the massage she performed on the painful and tense tissues in these areas by applying short and long stretching tractions with her fingers, her lower back pain disappeared, she got rid of her lower extremity complaints, and the previous amputation decision was abandoned (13). Subsequently, Maria Ebner contributed to the dissemination of CTM in England and after in various other countries. The therapeutic mechanism of action has not been fully elucidated, but Ebner and Schliack have opinions on this subject.

By applying the CTM method, a shear force is created between dermis-hypodermis or skin-underlying fascia. In addition, angular force is applied to the collagen fibers in order to create a reflex and mechanical effect. The therapeutic mechanism of action of CTM has not been fully elucidated. The views of Ebner and Schliack on this subject are as follows: Peripheral nervous system innervation of body parts shows a segmental distribution during embryological development. When the function of an organ is impaired, tension may occur in the skin and subcutaneous tissue, which is stimulated from the same level of that organ and the spinal cord. In addition, according to Ebner, CTM produces mechanical effects on connective tissue and some cells (mast cells,

glycosaminoglycan-producing fibroblasts). It activates reflex mechanisms that cause vasodilation by decreasing sympathetic activity. As a result, circulation increases in organs associated with the parasympathetic ganglion. Healing is accelerated by improving circulation. The tension of the connective tissue decreases and returns to normal. Collateral circulation is increased, muscle spasms and pain are reduced, and as a result, a balance is achieved in the autonomic nervous system (13,104). In addition, dermatomes and myotomes innervated from the same level of the dysfunctional organ and the medulla spinalis reflect this disorder as changes in the skin and subcutaneous tissues. These changes are symptoms such as edema, hyperalgesia, hardening and thickening. With the application of CTM to the affected dermatome, reflex effects may occur in the stimulated organ from the same segment as the dermatome (105). Reflex zones are called Head, Mckenzie and Connective Tissue zones (106).

- ***Head Zones:*** The change in the character of the interstitial fluid in the subcutaneous tissues is reflected as Head zones. These zones can be sensitive to touch, pressure, heat or cold.
- ***Mckenzie Zones:*** These are the areas where hypersensitivity and increase in tone are seen especially in the muscles of the back region, in accordance with the segment of the dysfunctional organ.
- ***Connective Tissue Zones:*** They are tense zones in the connective tissue in the segment associated with the dysfunctional organ.

2.6.1. Physiological Effects of Connective Tissue Manipulation

In CTM application, it is aimed to stimulate the sympathetic and parasympathetic balance in the autonomic nervous system. Parasympathetic pathways are generally used to achieve this balance. The mechanism of action of CMT is divided into local, segmental and general (suprasegmental) physiological effects.

- ***Local Effects of CTM***

CTM local effects include the release of histamine from mast cells and glucosaminoglucan from fibroblasts. In addition, there is local swelling at or near the stimulation area, as well as arteriolar dilatation induced by local axon reflexes. At the same time, a cutting sensation and swelling and redness of the skin may occur (105).

- ***Segmental Effects of CTM***

Segmental effects of CTM include affecting other structures and vessels in the segment suitable for the connective tissue. An improvement in the functions of the tissues innervated from the same spinal segment as the treated reflex zone is observed. The circulation of all structures increases, muscle tone and visceral functions improve. With these improvements, pain and tissue stiffness can be reduced. The effect achieved away from the treated area is explained by cutaneous reflex mechanisms (107).

- ***General (Suprasegmental) Effects of CTM***

Autonomic receptors are stimulated by strokes applied to the connective tissue and the impulses reach the autonomic centers. Thus, the establishment of balance in the autonomic nervous system and the initiation of endocrine responses are provided. This is among the general effects of CTM (107).

2.6.2. Techniques of Connective Tissue Manipulation

In CTM application, specialized stroke is applied to the connective tissue interfaces of the skin. This strokes are made very specifically where the fascia attaches to the bone or where the fascia is superficial and causes a slight shear force. The applied stroke should not be painful and uncomfortable. Optimal traction on the cutaneous tissue was achieved by applying specific short and long strokes using the middle fingers' pads from both hands.

- **Indications**

✓ Rheumatic diseases
✓ Low back pain
✓ Headache
✓ Connective tissue diseases and scar tissue
✓ Circulatory problems
✓ Gynecological, obstetric and hormonal disorders
✓ Neurological problems
✓ Respiratory diseases
✓ Psychiatric problems
✓ Visceral dysfunctions
✓ Digestive system diseases
✓ In cases of sympathetic pain

- **Contraindications**
- ✓ Malign tumors
- ✓ Acute inflammation
- ✓ Mental diseases
- ✓ Haemorrhage
- ✓ Tuberculosis
- ✓ Pregnancy

According to German experience, CTM provides benefits in cardiac and respiratory diseases, painful conditions, visceral dysfunctions, gynecological and obstetric problems, peripheral circulation problems, digestive and urinary system diseases. Some other communities of therapists recommend that CTM be primarily used to reduce symptoms of diseases such as osteoarthritis, peripheral and spinal joint dysfunction, rheumatoid disease, sciatica and neuralgia, and nerve root pain (106).

When the literature was reviewed, it was seen that CTM was used to provide pain control in fibromyalgia, migraine, low back and neck problems (108–111). There are few studies in which CTM is applied in gynecological, urological and gastrointestinal problems (15–17,112). There are also studies in which CTM is applied to increase circulation in peripheral arterial diseases (113,114). In addition, there is a study evaluating the acute effects of CTM on autonomic functions in healthy individuals (115).

In a study published in 2021, 34 women with OAB were divided into 2 groups. While only pelvic floor muscle training (PFMT) was given to one group, PFMT and CTM were applied to the second group. When the results were examined, it was seen that the second group was superior in reducing OAB symptoms in the early and late periods (16). Connective tissue changes can be seen on the sacrum in urinary system problems, especially bladder-related problems. Bladder functions can be regulated with CTM applied to this area.

3. MATERIAL AND METHODS

This study is designed as a prospective, RCT to compare the effects of CTM+PFMR applied for 8 weeks in children with LUTD to PFMR applied alone, on LUTD symptoms, uroflowmetry parameters, pelvic floor muscle functions, and quality of life.

This research was approved by Yeditepe University Clinical Research Ethics Committee (Meeting Date: 15.02.23, Referance Number: 2023/1719) (Appendix A).

3.1. Individuals

The study was conducted at Tuğtepe Pediatric Urology and Surgery clinic. Volunteer pediatric patients between the ages of 5 and 15, who were diagnosed with LUTD by a pediatric urologist, were included in the study. The required sample size for the study was calculated with the G*Power (G*Power Ver. 3.0.10, Franz Faul, Universität Kiel, Germany) package program. Minimal clinically important difference (MCID) of DVISS was used to determine the sample size. The power analyze indicated to enroll 4 experimental participants and 4 control participants to reject the null hypothesis with probability (power) 0.9. The Type I error probability related with this test of this null hypothesis is 0.05.

60 children diagnosed with LUTD were included. According to the inclusion and exclusion criteria, 16 patients were excluded from the study. The remaining 44 patients were divided into two groups using the block randomization technique. 1. PFMR group (n=22), 2. CTM+PFMR group (n=22). 2 people in the PFMR group (PFG) and 2 people in the CTM group (CTG) did not continue the study due to transportation reasons. Children who agreed to participate in the study and their parents were informed about the study. In addition, voluntary consent forms were signed by the parents and children. (Appendix B)

<u>Inclusion Criteria</u>

- Be in the age range of 5-15 years
- Having been diagnosed with LUTD by a pediatric urologist according to the criteria set by the ICCS
- Volunteering by the parent and child to participate in the study

Exlusion Criteria

- Having any problems of neurogenic origin
- Parent or child has any condition that affects responding to the scales to be used (mental, retardation, cognitive problems, etc.)
- Malformations or anatomical differences in the urinary system
- Participants who discontinued treatment
- Presence of a urological surgery history
- Be on medication
- Having constipation and/or fecal incontinence
- Have previously participated in pelvic floor muscle rehabilitation

With the block randomization technique, 22 children were included in the PFG and 22 children were included in the CTG.

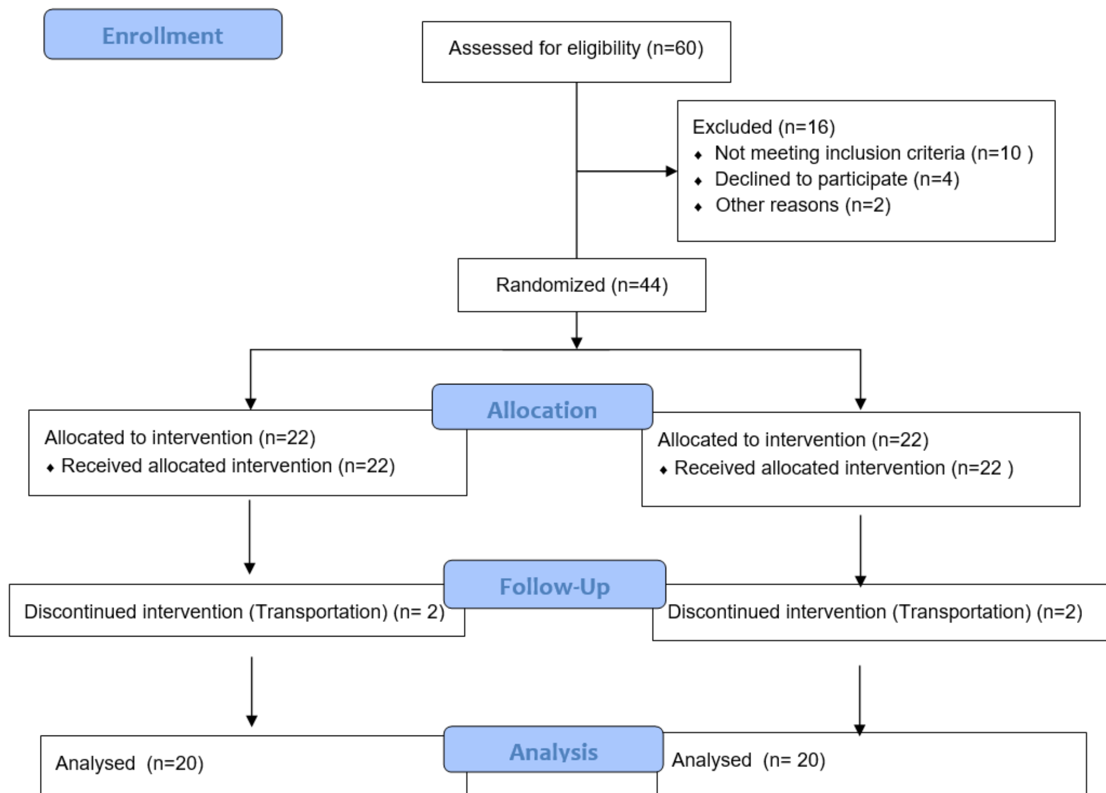


Figure 3.1. Flow Diagram

3.2. Assessment Methods

Parameters of the children participating in the study were evaluated at the beginning of the study (baseline), and after 8 weeks intervention (post-test).

3.2.1. Demographic and Clinical Symptoms Evaluations

Age (year), body weight (kg), height (m) of the patients were recorded in baseline and post-test. Seca brand scales were used to measure body weight and height. Body mass index values were calculated by dividing the body weights by the square of the height and expressed as kg/m2. During face-to-face interviews, pediatric urologists asked questions and obtained detailed histories from families and children regarding medication use, surgical history, cognitive and mental issues, neurological and/or anatomical problems, and clinical symptoms, which were recorded. Clinical symptoms evaluated by a pediatric urologist include urgency, frequency, hesitancy, daytime incontinence, enuresis, urinary tract infection (UTI), straining, dysuria, intermittency, feeling unable to empty the bladder, and holding maneuvers. The form in which the demographic and clinical characteristics of the patients are evaluated can be found in Appendix C.

3.2.2. EMG- Uroflowmetry

Uroflowmetry is a commonly used, non-invasive, simple, and inexpensive method for the functional evaluation of the lower urinary tract (59). In our research, uroflowmetry with EMG, which has a sensor system, branded as AYMED®, was used. Parents were informed before coming to the clinic that the child needed to drink enough non-irritable fluids before arrival. It was said that children should not consume excessive and rapid fluids in order to quickly achieve the desired urine fullness (116). Before the test, the child and his family were informed, and the child's perineum was cleaned and dried with an antiseptic. The test was administered when the child felt constricted with urine and performed by a technician experienced in uroflow-EMG. Superficial electrodes were placed just lateral to the external anal sphincter at the 3 and 9 o'clock positions and on the thigh region. The child was seated in the uroflow toilet. The child was told to stay still and not urinate until the EMG wave formation stabilized. If the child's feet did not touch the ground, a stool was placed under his/her feet. If the child asked the technician to come out, the technician went outside and the child stayed in the testing room with the parent during test (60).

Figure 3.2. AYMED EMG- Uroflowmetry Device

The parameters obtained as a result of the EMG-Uroflowmetry test are shown below:

- Voided Urine Volume (ml)
- Maximum flow rate (Qmax)
- Voiding time
- Flow time
- Average flow rate (Q_{ave})
- Time to maximum flow

The EMG-Uroflowmetry test was applied to the children in both groups both baseline and post-test. PFG and CTG parameters were compared baseline and post-test (Appendix D).

3.2.3. Post-Voiding Residue (PVR) Evalution

According to the standardization published by ICCS; It is significant when PVR is over 30 ml or more than 21% of bladder capacity in children aged 4-6 years, while it is significant when PVR is over 20 ml and greater than 15% of bladder capacity in 7-12 years old children (1). PVR is an important parameter for voiding dysfunction and a risk factor for UTI (117).

In our study, residual urine measurement in the bladder was performed immediately after the EMG uroflowmetry test. It is important to measure PVR within 5 minutes after voiding. If more time passes, the measurement is misleading (1). The

measurement was made by a pediatric urologist from the subrapubic region with a Telemed® brand transabdominal head device. This technique is preferred because it is non-invasive. For the measurement, the children were positioned in the supine position with their knees supported by a towel and slightly flexed. By using the probe of the device, the amount of residual urine remaining in the bladder after voiding was automatically calculated by the system (117). Baseline and post-test PVR assessments of children in both the study and control groups were performed.

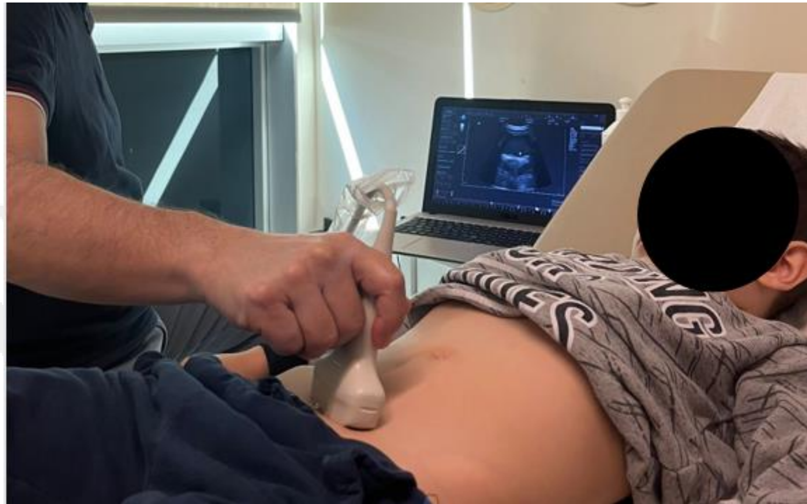


Figure 3.3. Post-Voiding Residue (PVR) Evalution

3.2.4. Bladder Diary

According to the standardization published by the ICCS, a bladder diary of at least 48 hours should be kept to evaluate the child with LUTD (1). With this diary, the child's daytime voiding frequency and volume, the amount and type of fluid taken can be evaluated (61). Therefore, it is an effective method for evaluating functional bladder capacity and fluid intake (118).

In our study, all children in both the PFG and CTG were asked to complete a 2-day detailed bladder diary with their parents in baseline and post-test. Parents were explained in detail how to fill out the diary and a written text was given. With this diary, the frequency of urination, the amount of urine, the amount of liquid drunk, the number of urinary incontinence during the day were recorded. The amount of fluid consumed by the child and the volume of voiding were recorded in milliliters (ml), and the duration of voiding in seconds (sec). The child's sense of urgency when urinating was recorded as "absent, little, moderate, and much" (Appendix E).

3.2.5. EMG - Pelvic Floor Muscle Activation Measurement

Electromyographic measurement (EMG), which is used to evaluate the PFM activation with surface electrodes, is an easy and non-invasive method. In the literature, it has been stated that it is appropriate to evaluate PFM activation in children using surface electrodes (66).

In our study, the PFM activations of the children in both the PFG and CTG were evaluated by the physiotherapist using the NeuroTrac Myoplus Pro4 baseline and post-test. In baseline, the parents and the child were informed about how the measurement would be made. The child was asked to urinate completely before the measurement was taken. Two superficial electrodes were placed in the perineal region at 2 and 7 o'clock. Thus, cross talk was tried to be prevented. In addition, the reference electrode was placed on the right thigh.

Figure 3.4. MyoPlus 4 Pro Device and Superficial Electrodes

The children were taught the correct PFM contraction to move in the ventral and cranial directions. The children observed their PFM contractions from the computer. The "Work-Rest Assestment" which lasted 55 seconds in total, was administered to each child with the same device. At first, the children were asked to provide relaxation in the pelvic floor muscles. Afterwards, 5 seconds of contraction (work) and 5 seconds of relaxation (rest) were provided, and a total of 10 rounds of PFM contraction and relaxation were requested. All measurements were performed by the same physiotherapist (9).

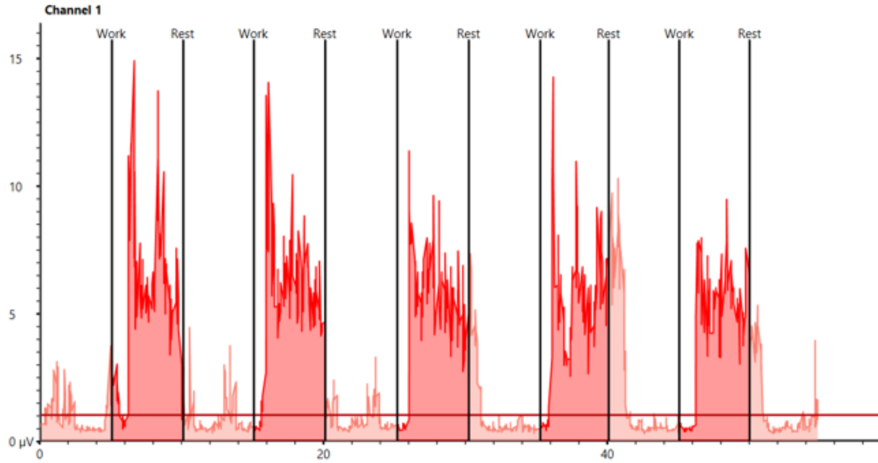


Figure 3.5. Work-Rest Assessment

3.2.6. Dysfunctional Voiding and Incontinence Scoring System (DVISS)

It is a questionnaire that evaluates the severity of LUTD and is completed by the parents. The questionnaire, which originally included 14 symptom-related questions and 1 quality of life question, was developed by Akbal et al. in 2005 to be suitable for the pediatric population. In the new version adapted by Akbal et al., there are 13 questions about symptoms and 1 question about quality of life. The score to be calculated is between 0-35 points. Akbal et al., when the quality of life question was excluded from the scoring, found the specificity and sensitivity of the scoring to be 90% in those who scored 8.5 and above. As the score obtained from the scale increases, the severity of the symptoms also increases (62).

In our study, parents of all children in both PFG and CTG were asked to fill out this questionnaire in baseline and post-test. Questionnaire questions were read to the parents one by one by the physiotherapist. The answers of the parents were recorded. (Appendix F).

3.2.7. Pediatric Urinary Incontinence Quality of Life Score (PIN-Q)

Bower et al. developed the PIN-Q scale in 2005 for use in children with urinary incontinence. The Turkish validity and reliability of the questionnaire was conducted by Hanımeli R. in 2011. The PIN-Q scale consisted of 28 questions in its initial development stages. It included areas where children's family, home and social relationships, body

image, mental health, independence, self-esteem, and treatment were evaluated. With the continuation of the studies, it was reduced to 20 questions and the evaluated areas were divided into two as external and internal. The internal dimension consists of fifteen questions and the external dimension consists of five different questions. Each question is scored from 0 (no), 1 (almost never), 2 (sometimes), 3 (often), 4 (always). Total score is 80. An increase in the total score indicates that the quality of life of the child worsens (63).

In our study, the PIN-Q scale was evaluated for all children in both the PFG and CTG in the baseline and post-test. The questions were read to the children one by one by the physiotherapist. Parents were removed from the room so that the answers would not change while the questions were read (Appendix G).

3.2.8. Connective Tissue Assesment

Before and after CTM intervention, patients should be carefully examined. Evaluation is carried out by examining the responses of inspection, palpation and circulation, respectively. With the inspection method, back muscle atrophies and hypertrophies in the back, sacral and shoulder region, bone deformities of the vertebral column, localized swellings can be examined. With palpation, the tension and mobility of both the superficial and deep connective tissue, and whether there is any asymmetry or tension difference on both sides of the body can be evaluated. The circulatory responses of the connective tissue are evaluated by traction on both sides of the vertebral column with the distal phalanx of the third finger from L5 to the occiput (13).

In our study, CTM evaluation was applied for the CTG to which CTM and PFMR would be applied. Connective tissue inspection, palpation and circulatory responses were examined and evaluated. Observations were made by inspection, and the patients who had findings were noted. Connective tissue mobility by palpation was classified as “low, moderate, and high”, and the circulatory response was classified as “low, normal, and high”. Sitting position, which is the most suitable position, was used for the evaluation of the connective tissue. The pelvis is slightly tilted forward while the back is straight. Hips and knees angled at 90°, feet supported on the floor and hands resting freely on thighs (104).

4. INTERVENTION

After the baseline evaluations were completed, PFMR was applied to the PFG and PFMR+CTM to the CTG. Each session of all children participating in the study was performed by the same physiotherapist. During the session, parents were taken out so that the children could focus. Only one physiotherapist and one child were present in the session room during each session. There was a Bobath treatment table and necessary equipment in the session room.

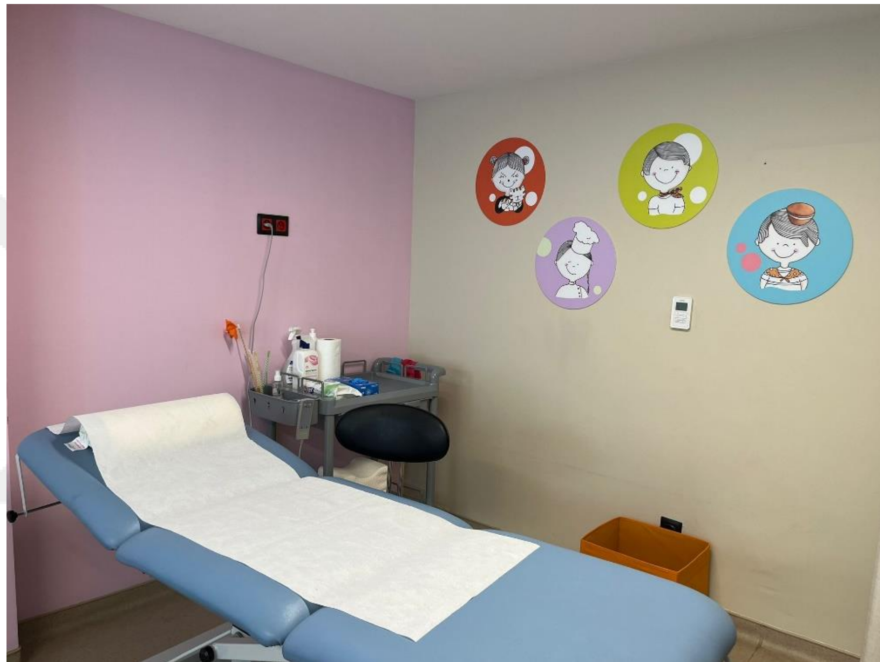


Figure 4.1. Session Room

4.1. Pelvic Floor Muscle Rehabilitation Program

In our study, PFMR was applied to both the PFG and CTG. Included in PFMR are;

- Standard Urotherapy
- Diaphragm Breathing Exercise
- PFM Exercises with Biofeedback

4.1.1. Standard Urotherapy

Urotherapy is the first-line treatment option in children with LUTD. In our study, all children in both the PFG and CTG and their parents received standard urotherapy training before PFMR and CTM interventions. The standard urotherapy method applied

in our study includes the subheadings of introduction, life-style advice, instruction, registration and support and encouragement. The standard urotherapy session lasted approximately 60 minutes.

- **Information**

The child and his parents were told about the LUT function and the LUTD the child has. Care was taken to support the child, not to scare or say negative things. How the correct LUT functions are realized was shown by watching the video with animations (119).

- **Instruction**

Before their parents came to the urotherapy session, they filled out their child's bladder diary. Bladder diary was examined during the urotherapy session. As a result of bladder diary and uroflowmetry evaluation, regular voiding and fluid intake times were determined for the child. Except for children with overactive bladder or frequent urination problems, the rule of regular urination every 2-3 hours and drinking water was applied. If the child urinates frequently and cannot tolerate 2 hours, shorter periods (such as 1.5 hours) were started. Bladder training was provided with regular fluid intake and regular voiding. Children and parents were informed about the correct toilet position. It was said that the feet should touch the ground completely during voiding. If the child's feet did not fully touch the floor, they were asked to buy a toilet stool. Thus, it was aimed to provide adequate PFM relaxation during voiding and defecation (119). In our study, the position where the feet touch the ground and the angle of the sole of the foot and the knee is 90 degrees is suggested. The hips should be abducted, the back straight, and the trunk very slightly forward flexed (68). If the child had UTI or the amount of PVR was more than the limits specified by ICCS, the "double voiding" method was taught. It was aimed to better empty the bladder by urinating again a few minutes after the child's toilet and to reduce the amount of PVR (120). The child and family were taught not to delay urination and to urinate before the feeling of urgency.

- **Life-style Advice**

It was aimed to achieve a regular bladder and bowel emptying pattern with balanced fluid intake and diet. The fluid intake of children, varying according to age, was divided equally during waking hours. Thus, it was aimed to provide a regular bladder filling (68). In our study, it was stated in the urotherapy session that children should empty

their urine every 2 hours and consume regular fluids, except for children with OAB and frequent urination. Thus, by establishing the routine bladder filling and emptying cycle, pelvic floor holding maneuvers are minimized, the irritative effect of urine concentration is reduced and LUTD rehabilitation is facilitated (4). Children were asked not to consume foods and beverages that cause bladder irritation during the treatment process. Among these bladder irritants defined as 5C;

- Caffeine (such as cola, coffee, tea)
- Carbonation (any carbonated beverage)
- Citrus (such as orange, lemon and grapefruit and their extracts)
- Chocolate
- Coloring (any food or drink containing dyes or colourants).

- **Registration**

In our study, the child and family were asked to take responsibility together in the follow-up of bladder diaries. Thus, it is aimed to raise awareness about the child's bladder and its function. In our study, it was aimed to personally participate in the treatment process of the child.

- **Support and encouragement**

In our study, the child was supported and encouraged during the treatment. Families were taught the reward system. In this reward system, the child achieved access to the award by following the rules he received in urotherapy training. Participation of families in treatment was supported and encouraged.

4.1.2. Diaphragm Breathing Exercise

Before starting PFM exercises, diaphragm breathing (DB) exercise was applied to children in both the PFG and CTG. It was aimed to provide maximum relaxation in abdominal and pelvic floor muscles with DB exercises. This exercises were performed with a physiotherapist 3 days a week for 8 weeks. First, the patient was positioned in the supine position on the Bobath treatment table. The children were asked to relax their heads and shoulders, and backs on the bed. The knees were supported by a pillow and positioned in slight flexion (10). After positioning, one of the children's hands was placed on the thorax and the other hands were placed on the level of the umbilicus in the abdomen (96,121). After the correct position was achieved, the patients were asked to take a slow

breath through their nose and deliver the breath in the cranio-caudal direction. Here, after holding their breath for a few seconds, they were asked to exhale slowly with a pursed lip (10). It was expected that the hand on the thorax would move minimally during the exercise, while the hand at the umbilicus level was expected to move up during inspiration and downward during expiration. This exercise was performed in 3 sets of 10 repetitions.

Figure 4.2. DB Exercises in Supine Position: Inspiration

Figure 4.3. DB Exercises in Supine Position: Expiration

4.1.3. PFM Exercises with Biofeedback

PFM exercises were applied to the children in both the PFG and CTG, 3 times a week, accompanied by a physiotherapist. It was applied for 8 weeks. The patient was positioned in the supine position, with the knees supported by a pillow. This exercises were applied after maximum relaxation was achieved in abdominal and pelvic floor muscles with DB exercises. Before starting the session, patients were asked to empty their bladders. First, the physiotherapist applied external palpation to the perineum and taught the patient to contract and relax the pelvic floor muscles. The patient was asked to contract and relax the PFM without the use of accessory muscle (10,122). If the patient was unable to relax PFM sufficiently, biofeedback approaches for relaxation were applied. After the

patient learned how to contract and relax the PFM correctly, animated biofeedback supported PFM exercises were started. Superficial electrodes were used with the NeuroTrac Myoplus Pro4 device. Electrodes were attached to the perineal region at the 2 and 7 o'clock positions as in the PFM activation assessment. The reference electrode was also attached to the right thigh. The exercises were initially performed in the supine position where gravity was eliminated. As the patient's contraction abilities improved, it was applied in sitting and standing positions against gravity. Exercises including 2-5 seconds of contraction and 5-10 seconds of relaxation were performed for a total of 20 minutes (9). Bunny and Plane games with animations on the NeuroTrac Myoplus Pro4 device were preferred. Children were motivated by these games. The physiotherapist checked the children's use of accessory muscles by observation and palpation throughout the exercise. Particularly palpating and observing the abdominal, gluteal, and adductor muscles helped to perform the exercise correctly. In addition, regular referrals were made by the physiotherapist since the child should not squeeze his body and close the glottis during contraction.

4.2. Connective Tissue Manipulation

CTM treatment was applied only to the children in the CTG, 3 days a week for 8 weeks by the same physiotherapist. Each session was applied for approximately 20-25 minutes. Before the CTM intervention, parents and children were informed about the application. The patients were informed that during and/or after the intervention, they may experience a painless, mild itching sensation, and hyperemia may occur in the area due to a local reaction (123). The innervation areas of the bladder come from the thoracolumbal and sacral regions. In addition, bladder problems are reflected in the sacral region as a reflex area. Since the peripheral branches of this region will be located in the abdominal and anterior pelvic regions, CTM treatment was performed on the lumbosacral (basic) region, lower thoracic region, abdominal and anterior pelvic regions (104). The distal interphalangeal joint of the middle finger was positioned at a 45-degree angle to the skin, with flexion. Slow strokes were performed with the middle finger to create traction in the cutaneous and subcutaneous tissue. Thus, friction was provided in the superficial fascia and mechanoreceptors were stimulated (123).

Positioning of Patients

In lumbrosacral and lower thoracic interventions, the patient sat on a stool with his/her back straight. The hips and knees were flexed to 90 degrees and the feet were positioned with support. The hands were left in a free position on the thighs. When applying to the abdominal and anterior pelvic region, the patient was placed in the supine position. It was supported by placing a thin pillow under the head and thighs (13).

4.2.1. CTM Application to the Lumbosacral (Basic) Region

1. The short strokes that start from the lateral edge of the sacrum, progress towards the iliac crest, and terminate at the anterior superior iliac spine, with a direction from lateral to medial was applied. CTM was applied 3 times on the right side and then 3 times on the left side at each stage.
2. Long strokes was applied to the lateral edge of the sacrum in an oblique fashion from superior to inferior.
3. Short strokes from lateral to medial were applied to the lumbo-sacral angle.
4. Three different long strokes were applied on the ilium from medial to lateral.
   - Starting at the level of the transversal process of L5 and ending at the anterior superior iliac spine
   - Starts from the widest part of the sacrum and ends in the anterior superior of the spina iliaca
   - Starts from the anal line and ends above the trochanter major
5. Paravertebral short strokes were performed from medial to lateral from L5 to T12.
6. Subcostal long strokes were performed from medial to lateral.

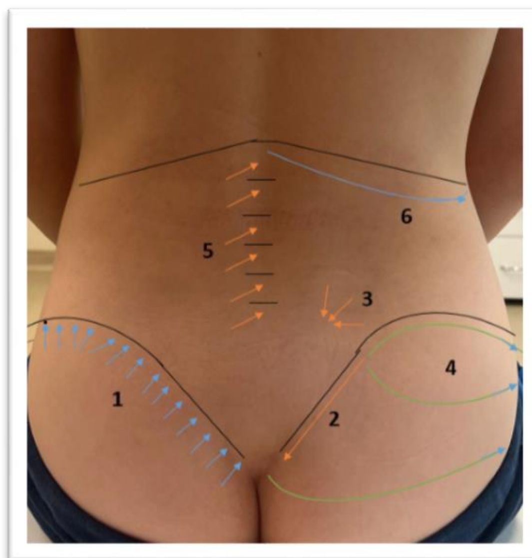


Figure 4.4. Lumbosacral (Basic) Region CTM

4.2.2. CTM Application to the Lower Thoracic Region

1. Short strokes were performed along the lateral edge of the M. latissimus dorsi, starting from the iliac crest and continuing from the lateral to the medial towards the axillary edge.
2. Short strokes were performed on the erector spina from the paravertebral T12 to T7.
3. Intercostal long strokes were performed from lateral to medial.
4. Long strokes were applied to the inferior angle of the scapula from lateral to medial.

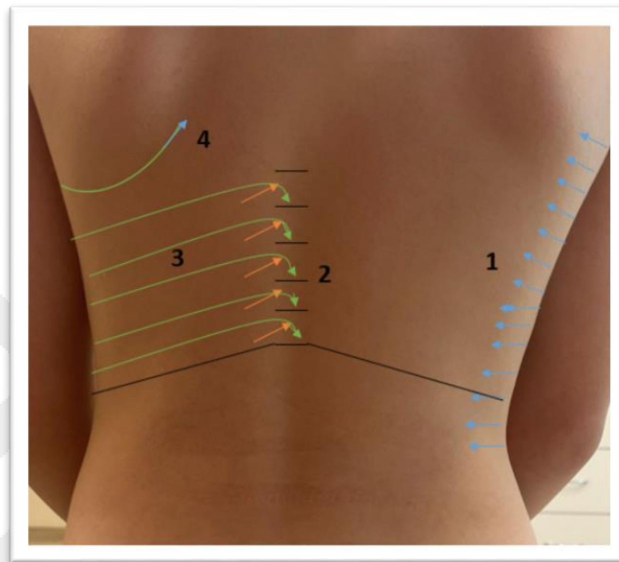


Figure 4.5. Lower Thoracic Region CTM

4.2.3. CTM Application to the Abdominal Region

1. Short strokes were performed from the lateral-inferior costal border to the xiphoid process.
2. Subcostal long strokes were performed from lateral to medial to the tip of the sternum.
3. Starting from the superior and lateral iliac crest, short strokes were performed towards the symphysis pubis.
4. Long strokes were applied on the iliac crest from the lateral to the symphisis pubis.
5. Short strokes were performed from the inferior to the superior lateral border of the M. rectus abdominis.

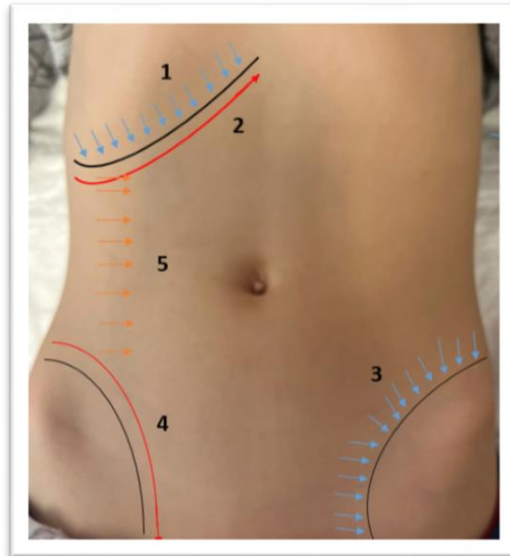


Figure 4.6. Abdominal Region CTM

4.2.4. CTM Application to the Anterior Pelvic Region

1. Subcostal long strokes were performed from lateral to medial to the tip of the sternum.
2. Long strokes were applied on the iliac crest from the lateral to the symphisis pubis.
3. Long strokes were applied to the pelvic cavity.

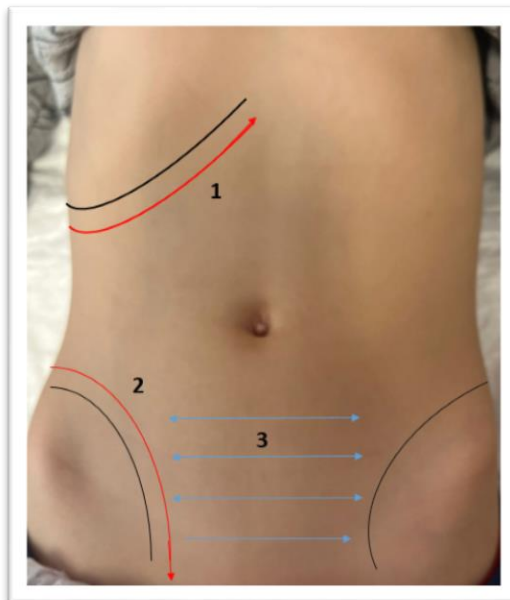


Figure 4.7. Anterior Pelvic Region CTM

Data Analysis

Statistical Package Analyze for Social Sciences (SPSS) version 29.0 was used for data analyses (SPSS Inc. Chicago, IL, USA). The Kolmogorov-Smirnov test was used to test the numerical variables for normality. The summary of numerical data was showed mean ± standard deviation and ratio was used for categorical data. Statistical analysis was performed before and after treatment for parametric and non-parametric data with respectively Paired Sample T-test and Wilcoxon test. The significance level was accepted 0.05

5. RESULTS

The study included 40 LUTD children who applied to Tuğtepe Pediatric Urology and Surgery Center of Istanbul, Turkey. The study was conducted between the period of February 2023 to September 2023. The intervention period for each participant included in the analysis was 8 weeks. 'Statistical Package Analyze for Social Sciences' (SPSS) version 29.0 was used for data analyses in this study. The level of significance were accepted as $p \leq 0.05$.

5.1. Physical Characteristics and Demographic Information

The values of mean age, height, weight, and body mass index of groups in baseline were given on Table 5.1. There was no statistically significant difference between the groups ($p > 0.05$).

Table 5.1. Physical Characteristics and Toilet Training age of the PFG and CTG

	PFG	CTG	
Variables	Mean±SD	Mean±SD	p value
Age (Years)	8.8±1.91	7.8±1.64	0.091
Weight (kg)	29.33±8.65	27.01±11.22	0.079
Height (cm)	133.6±8.76	128.33±12.64	0.129
BMI(kg/m²)	16.2±3.21	15.94±3.66	0.403
Toilet training (Years)	2.63±0.46	2.8±0.5	0.275

Mann Whitney U Test, SD: Standard Deviation, BMI: Body Mass Index, kg: kilogram, m: meter, kg/m²: kilograms/meter square, PFG: Pelvic Floor Group, CTG: Connective Tissue Group

The gender distribution of the childrens is shown in Table 5.2. There was no statistically significant difference between the groups (p>0.05).

Table 5.2. Comparison of Gender Distribution Between Groups

	PFG		CTG		p value
Gender	n	%	n	%	
Male	15	75	16	80	
Female	5	25	4	20	0.705
Total	20		20		

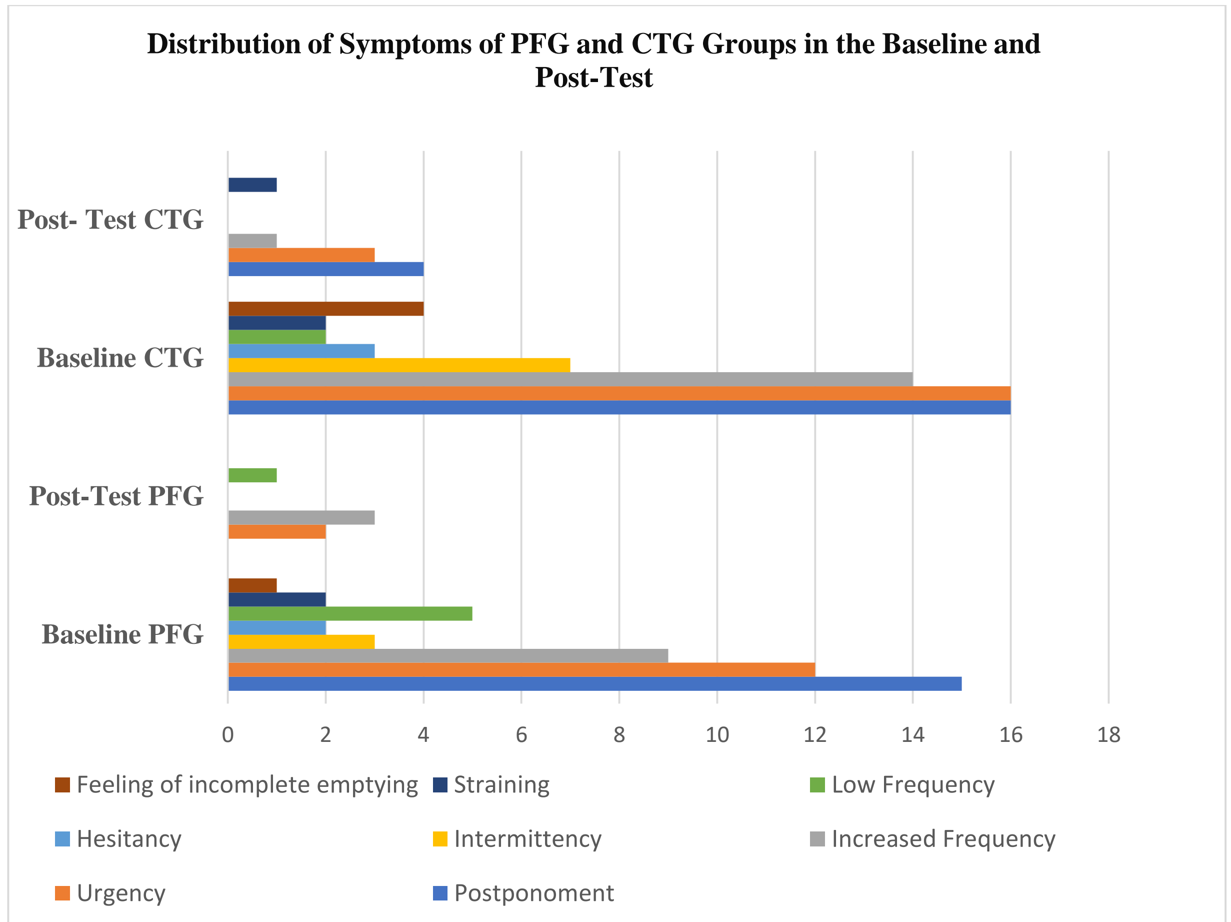
Chi-square test, n: number, PFG: Pelvic Floor Group, CTG: Connective Tissue Group

5.2. Evaluation of Symptoms

Symptoms assessed by the pediatric urologist were similar at baseline in both groups (p>0.05). The most common symptoms in both groups were urgency, frequency, intermittency, and postponement. In the baseline, 80% of CTG and 60% of PFG had urgency symptoms. While postponement was present in 80% of CTG and 75% of PFG, the frequency was present in 70% of CTG and 45% of PFG in the baseline. In addition, symptoms of intermittency, hesitancy, low frequency, straining and feeling of incomplete emptying were also observed in some children.

In post-test evaluations, both CTG and PFG urgency, frequency, and postponement symptoms improved statistically significantly (p<0.01). There was no statistically significant difference between the two groups in post-test analyses (p>0.05). Table 5.3 shows the symptom distributions of the groups at baseline and post-test.

Table 5.3. Distribution of Symptoms of PFG and CTG in the Baseline and Post-Test



Chi-Square test, PFG: Pelvic Floor Group, CTG: Connective Tissue Group

At baseline, the average DVISS score of PFG was 12.4±3.42, while that of CFG was 16.85±5.75, and the difference between them was statistically significant (p=0.001). When the groups were evaluated within themselves as baseline and post-test, a statistically significant improvement was observed in symptom scores in both groups (p=0.001). In the post-test, CFG decreased to an average of 0.9±1.41, while PFG decreased to 2.15±3.51. CFG showed statistically greater change in a positive way (p=0.001). Table 5.4. shows the changes and comparision in DVISS scores within the groups in the baseline and post-test periods.

As a result of difference analysis, CFG decreased statistically significantly more in the post-test compared to PFG. Table 5.4. shows the changes and comparision in DVISS scores within the groups in the baseline and post-test periods.

Table 5.4. In-group Changes and Comparison of DVISS Score at the Baseline and Post-Test

DVISS	PFG					CTG					%95 CI	p
	Baseline	Post-Test	Δ	z	p	Baseline	Post Test	Δ	z	p	(-14.9)-(-11.3)	***0.001***
	12.4±3,42	2.15±3.51	-10.25±4.27	-3.923	**0.001**	16.85±5.75	0.9±1.41	-15.95±5.49	-3.928	**0.001**		

Data expressed in Mean±SD, Wilcoxon Testi **p<0.01, PFG: Pelvic Floor Group, CTG: Connective Tissue Group

5.3. Uroflowmetry and Bladder Diary Results

Baseline uroflowmetry and bladder diary results of the groups are similar to each other ($p>0.05$). When the groups were compared within themselves, statistically significant improvements were observed in certain uroflow and bladder diary parameters in both PFG and CTG. When the baseline and post-test were compared in groups, Voided Volume, O-Ave and PVR parameters changed statistically significantly in PFG, while Q-Max and flow time parameters also changed in addition to these parameters in CTG ($p<0.01$). While the Q-Ave value was 6.35±3.32 (mL/sec) at baseline in PFG, it increased to 10.05±3.47 (mL/sec) in the post-test. In CTG, it was 5.34±2.76 (mL/sec) at baseline and it increased to 12.29±3.1 (mL/sec) in post-test. In this way, the difference in increase between the groups was found to be statistically significant ($p=0.001$).

While the maximum voided volume parameter in the bladder diary was 208.75±64.03 (mL) in the post-test in the PFG, it increased to 214±53.05 (mL) in the CFG and the difference in increase between them was statistically significant ($p=0.001$). In addition, while the incontinence frequency was 1.65±1.9 (times/day) in PFG at baseline, it decreased to 0.25±0.64 (times/day) in the post-test, which was found to be statistically significant ($p=0.001$). In CTG, it decreased statistically more than PFG, decreasing from 2.8±1.91 (times/day) at baseline to 0.15±0.37 (times/day) in the post-test ($p=0.001$). Another bladder diary parameter, voiding frequency (times/day), did not show a statistically significant difference in the post-test in both groups ($p>0.05$).

Table 5.5. shows the results of uroflowmetry parameters and bladder diary of the groups in the baseline and post-test.

Table 5.5. In-group Changes and Comparison of Uroflovmetry-Bladder Diary Parameters Between Groups at the Baseline and Post-Test

	PFG					CTG					%95 CI	p
	Baseline	Post- Test	Δ	z	p	Baseline	Post-Test	Δ	z	p		
Uroflovmetry Variables												
Voided Volüme (mL)	171.78±86.25	245.08±79.41	73.3±119.36	-2.837	**0.001**	155.07±72.4	230.28±78.71	75.21±50.78	-3.659	**0.001**	(45,29)-(103,2)	0,999
Q-Max (mL/sec)	16.67±6.52	18.44±5.49	1.76±7.43	-0.765	0.444	14.11±3.11	17.87±4.44	3.75±2.99	-3.734	**0.001**	(0,94)-(4,57)	0.130
Q-Ave (mL/sec)	6.35±3.32	10.05±3.47	3.7±4.69	-2.949	**0.003**	5.34±2.76	12.29±3.1	6.95±3.9	-3.808	**0.001**	(3,86)-(6,78)	**0.001**
Flow Time (sec)	23.5±7.15	24.03±9.35	0.53±11.35	-0.037	0.970	22.01±6.91	17.73±6.56	-4.29±7.7	-2.091	**0.001**	(-5,03)-(1,28)	0.185
PVR (mL)	28±32.65	11.9±12.88	-16.1±28.8	-3.301	**0.001**	32.95±26.93	16±15.61	16.95±18.48	-3.143	**0.001**	(-24,16)-(-8,88)	0.308
Bladder Diary Variables												
Maximum Voiding Volume (mL)	177.65±69.29	208.75±64.03	31.1±57.16	-2.616	**0.009**	138.25±45.52	214±53.05	75.75±2232	-3.930	**0.001**	(37,9)-(68,9)	**0.001**
Voiding Frequency (times/day)	7.35±2.41	6.9±0.97	-0.45±2.16	-0.641	0.522	7.45±2.28	6.35±0.59	-1.1±2.25	-1.921	0.055	(-1,47)-(-0,07)	0.297
Incontinence Frequency (times/day)	1.65±1.9	0.25±0.64	-1.4±1.82	-3.266	**0.001**	2.8±1.91	0.15±0.37	-2.65±1.76	-3.842	**0.001**	(-2,62)-(-1,42)	**0.001**

Data expressed in Mean±SD, Mann Whitney U Test, PFG:Pelvic Floor Group, CTG:Connective Tissue Group, mL:Milliliters, sec:second, mL/sec : milliliters in 1 second,tines/day:times in 1 day

5.4. EMG-PFM Activation Assestment

Baseline EMG-PFM activation parameters of the groups were similar to each other other ($p>0.05$). When the groups are evaluated within themselves as baseline and post-test, Work Average, Work Average Deviation, Work MVC and Rest MVC changed statistically significantly in PFG, while in CTG, in addition to these parameters, Rest Average Deviation also changed statistically significantly ($p=0.001$). While the mean Rest Average Deviation was 38.22±17.87 (%) in CTG at baseline, it decreased to 31.39±11.73 (%) in the post-test and is statistically significant. While the Rest Average was 1.24±0.43 (μV) at baseline in CTG, it decreased to 0.94±0.36 (μV) in the post-test, but it was not found to be statistically significant ($p>0.05$). This parameter was found to be statistically significant in PFG, decreasing from 1.27±0.35 (μV) at baseline to 0.9±0.31 (μV) in the post-test ($p=0.001$).

While the mean work average in the baseline was 6.99±3.26 (μV) in PFG, it increased to 10.05±3.45 (μV) in the post-test ($p=0.001$). While the mean work average in CTG was 6.53±3.89 (μV) at baseline, it increased to 11.14±4.97 (μV) in the post-test ($p=0.001$). When the difference analysis was made, the work average increase of CTG was found to be statistically higher than PFG ($p=0.001$). Table 5.6. shows EMG-PFM activation at baseline and post-test, comparing both within the group and between the groups.

Table 5.6. In Group Changes and Comparison of EMG-PFM Activation Parameters Between Groups at the Baseline and Post-Test

	PFG					CTG					%95 CI	p
	Baseline	Post-Test	Δ	z	p	Baseline	Post-Test	Δ	z	p		
Work Average (μV)	6,99±3,26	10,05±3,45	3.06±2.11	-3.703	**0.001**	6.53±3.89	11.14±4.97	6.16±2.68	-3.921	**0.001**	(3,69)-(5,52)	**0.001**
Work Average Deviation (%)	40,33±13,82	29,55±8,84	10.78±10.62	-3.323	**0.001**	39.91±11.79	27.27±7.99	14.51±9.38	-3.771	**0.001**	(-15,8)-(-9,42)	0.192
Work MVC (%)	32,08±11,3	39,24±11,98	7.17±12.47	-2.333	**0.001**	31.45±10.55	41.91±10.39	13.76±9.09	-3.733	**0.001**	(6,85)-(14,06)	0.081
Rest Average (μV)	1,27±0,35	0,9±0,31	-0.37±0.3	-3.518	**0.001**	1.24±0.43	0.94±0.36	-0.24±0.65	-1.679	0.093	(-0,46)-(-0,14)	0.369
Rest Average Deviation (%)	39,75±15,47	35,09±13,31	-4.67±12.24	-1.568	0.117	38.22±17.87	31.39±11.73	-8.99±17.45	-2.371	**0.001**	(-11,6)-(-2,01)	0.758
Rest MVC (%)	6,32±2,77	3,84±1,81	-2.48±3.49	-2.857	**0.001**	7.18±4.83	4.07±1.95	-3.75±6.01	-3.080	**0.001**	(-4,67)-(-1,54)	0.925

Data expressed in Mean±SD, SD: Standard Deviation, Mann Whitney U Test, SD: Standard Deviation, PFG: Pelvic Floor Group, CTG: Connective Tissue Group, μV: microvolt, MVC: Maximum Voluntary Contraction

5.5. Quality of Life Results

There is a statistical difference between the PFG and CTG in baseline (p=0.001). The PIN-Q mean of the PFG was statistically significantly lower in the baseline compared to the CFG (p=0.001). When the groups are examined within themselves in baseline and post-test, there is a statistically significant improvement in both PFG and CTG (p=0.001). When difference analysis was performed between groups, CTG decreased statistically significantly more than PFG (p=0.001). Table 5.7. shows he in-groups changes and comparision of the PIN-Q scores between groups at the baseline and post-test.

Table 5.7. In-Groups Changes and Comparision of the PIN-Q Scores Between Groups at the Baseline and Post-Test

PIN-Q	PFG					CTG					%95 CI	p
	Baseline	Post-Test	Δ	z	p	Baseline	Post Test	Δ	z	p		
	10,95±4,95	2.1±4.75	-8.85±5.68	-3.851	**0.001**	17.8±8.9	0,9±1.59	-16.9±9.39	-3.922	**0.001**	(-15,6)-(-10,1)	**0.001**

Data expressed in Mean±SD, Wilcoxon Testi **p<0.01, PFG: Pelvic Floor Group, CTG: Connective Tissue Group

5.6. Connective Tissue Evaluation Results

In baseline, connective tissue evaluation was performed by a physiotherapist only in the CTG. Palpation and circulation responses of the children in the CTG group were evaluated. The same evaluation was applied in the post-test. When evaluated by palpation, there is a statistically significant difference when CTG is compared as baseline and post-test ($p=.030$, $p<0.05$). When the circulatory response is evaluated, there is no statistically significant difference when CTG is compared as baseline and post-test ($p>0.05$). Table 5.8 shows the evaluation results of CTG's palpation and circulatory responses.

Table 5.8. Palpation and Circulatory Responses of CTG at the Baseline and Post-Test

		Baseline (n)	Post-Test (n)	X^2	p
Palpation	Low	8	2	7.000	**0.030**
	Moderate	9	16		
	High	3	2		
Circulatory Response	Low	2	0	13.003	0.095
	Normal	16	18		
	High	2	2		

Chi-Square Test ,**$p<0.01$, n: number

6. DISCUSSION

The findings of this study revealed that CTM, when applied as an adjunct to PMFR, was effective on symptom score, uroflowmetry and bladder diary parameters, EMG- PFM activation, and quality of life.

This study indicated that the DVISS score, which evaluates symptom severity, decreased statistically significantly in the post-test in both groups, but CTG showed more improvement than PFG. To the best of our knowledge, there are no studies including CTM intervention in children with LUTD. On the other hand, there is a study evaluating the symptom score before and after CTM in adult women with OAB (16). Karaaslan et al. in 2021, they applied CTM in addition to PFMT for 6 weeks to a group of women with OAB and compared its effects with the group that received PFMT alone. CTM was applied by a physiotherapist 3 days a week for 6 weeks. PFMT was applied for 6 weeks, followed by home exercises. Participants' PFM strength, bladder and OAB symptoms, and quality of life were evaluated before treatment, during the 3rd week of treatment, and after treatment. It has been shown that CTM gives better results in reducing symptoms in the early and late periods in the group in which CTM was applied in addition to PFMT (16). In a study published by Pekbay et al. in 2019, 24 children diagnosed with OAB resistant to standard urotherapy and antimuscarinic treatment were included and the effect of biofeedback-supported PFM therapy on symptoms, uroflow parameters, bladder capacity, and PFM activity was investigated. In this symptom scores were evaluated with DVISS, similar to our study and a positive improvement in symptoms was observed as a result of the study (9).

We assumed that CTM creates local mechanical effects with stokes on the connective tissue and some cells (e.g. histamine-releasing mast cells, glucose-amino glycan-producing fibroblasts), reducing sympathetic activity and causing vasodilation. As a result, the circulation in the organs related to the parasympathetic ganglion may be increased, the circulation in the body improved and the healing accelerated by establishing a balance in the autonomic nervous system (13). CTM can suppress the increased afferent impulses coming from the bladder by restoring the balance in the autonomic nervous system in the internal organs in the same segment through cutanovisceral reflex pathways. We may conclude that CTM is effective in the positive

development of the DVISS score by affecting urgency and frequency, which are the most common symptoms in the children in our study, through these mechanisms.

Another finding of this study is that Q-max and flow time, which are among the uroflowmetry parameters, changed statistically significantly only in CTG. Furthermore, in the comparison between groups, the Q-Ave parameter showed a statistically significant improvement in CTG compared to PFG. To our knowledge, there is no study in the literature investigating the effect of CTM on uroflowmetry and bladder diary parameters in children with LUTD. However, there are a limited number of studies evaluating the effect of PFM exercises on uroflow parameters (5,9,12,74). In the systematic review and meta-analysis published in 2021, fifteen studies, seven of which were RCTs, were examined to evaluate the effectiveness of biofeedback treatment in children with non-neurogenic voiding dysfunction. After detailed review, a total of 539 patients, 294 in the biofeedback group and 245 in the urotherapy group, were included in the meta-analysis. As a result of the study, it was shown that PFM exercises performed with biofeedback were more effective on maximum and average urine flow rate and that their long-term effects were more permanent (74). Although it is controversial as to which component of the autonomic nervous system is affected more by CTM, the changes in uroflowmetry parameters in our study show that CTG may cause Q-Ave, and Q-Max parameters to increase and flow time to decrease by balancing parasympathetic activation. Thus, the maximum and average urine flow rate of children increased and reached normal limits, the urine flow time was reduced and a more comfortable micturition was achieved. Local mechanical effects created in some cells by specific strokes applied to the connective tissue lead to the restoration of the balance between the sympathetic and parasympathetic fibers of the autonomic nervous system. Since the autonomic nervous system is also responsible for urination, these changes in uroflowmetry parameters on CTG may be achieved by the regulation of the system.

As for in-group comparisons showed that although both groups statistically improved bladder diary parameters after 8 weeks of intervention, maximum voiding volume, and incontinence parameters were statistically higher development in the CTG. In a study published in 2021 similar to our study, women with OAB were divided into 2 groups, CTM was applied in addition to PFT in one group, and only PFT was applied in the other group, and bladder functions were evaluated with a 3-day bladder diary. While frequency and incontinence episodes improved in both groups, nocturia, and average

voided volume improved only in women who underwent CTM (16). Another similar to the PFG group of our study, in a randomized controlled study conducted in children with DV, only urotherapy was applied to first group, and PFM exercises were applied to the second group in addition to urotherapy. children's bladder and bowel diary, uroflowmetry parameters, and PVR were evaluated. The results of the study showed that PFMR was effective on incontinence frequency and PVR, similar to our study (12). Consistent with the literature, PFMR and CTM were found to be effective on LUTD symptoms, uroflowmetry and bladder diary parameters. The reason for the greater decrease in incontinence episodes and the greater increase in the maximum voiding volume in CTG may be related to the restoration of the on the above-mentioned autonomic system and the inhibition of increased afferent impulses coming from the bladder. With the decrease of increased afferent impulses, more urine retention in the bladder may have occurred, leading to an increase in functional bladder capacity and a decrease in incontinence episodes. We predict that the reduction of incontinence episodes, children's ability to hold their urine for longer periods of time, and their ability to urinate in better uroflowmetry patterns will positively affect children's behavioral and emotional problems, quality of life, and psychological effects. Research in the literature has shown that incontinence is associated with negative situations such as emotional and behavioral problems, school failure, and peer bullying (124).

The study also showed that different EMG-PFM activation evaluation parameters changed statistically significantly in both groups at post-test, but the average activation during contraction (Work Average (μV)) changed more in CTG than in PFG. Furthermore, the Rest Average Deviation (%) parameter showed a statistically positive change only in CTG. It is known that connective tissue dysfunctions can have a negative effect on skeletal muscles (125). There are studies in the literature where CTM is used for problems related to the musculoskeletal system (109,110,126). In the study of Bakar et al. published in 2023, 45 women between the ages of 25-45 who experienced chronic neck pain were divided into 2 groups. Classical massage (CM) was applied to one group and CTM was applied to the other group. The muscle relaxation response was evaluated with Electromyography Biofeedback, and the pressure pain threshold was evaluated with an algometer. As a result of the study, it was found that the EMG response changed statistically in CTM, and therefore CTM showed a relaxation response (126). Consistent with the literature, in our study, the "Rest Average Deviation (%)" parameter, which is

related to the stability of muscle relaxation, changed statistically significantly only in the group where CTM was applied. Moreover, the Work Average (μV) parameter, which gives the average contraction activation of the muscle, increased more in the CTM applied group compared to the other.

Skeletal muscles produce more force when they are at optimal length. These muscles can also reach their optimal length at the most appropriate resting length (127). CTM restores the autonomic system through the previously mentioned mechanisms, reducing connective tissue tension, and resulting in increased collateral circulation. Regulation of circulation accelerates healing and leads to the regulation of muscle tone (13). The study published by Dönmez et al. in 2023 also supports this idea. Dönmez et al. distinguished PFM functions and evaluated PFM activation in specific positions. The study showed that PFM contracts the most in the position where it is most relaxed (127). Consistent with our study, the more stable resting tone in the CTG group may have caused the muscle to provide more contraction activation.

Another finding of our study is that the PIN-Q score, which evaluates the quality of life, decreased statistically in the post-test in both groups, but it decreased statistically more in CTG than in PFG. A decrease in the PIN-Q score indicates an increase in quality of life. In the randomized controlled trial conducted by Orhan et al. 40 children with cerebral palsy and chronic constipation were divided into 3 groups: CTM, kinesiotape, and control groups. Only lifestyle changes were applied to the control group, Kinesio taping was applied 3 times a week for 4 weeks in addition to lifestyle changes to the kinesiotape group, and CTM was applied 3 days a week for 4 weeks to the CTM group in addition to lifestyle changes. As a result of the study, they showed that CTM is an effective intervention in improving the quality of life (18). In another similar randomized controlled study conducted by Gürsen et al., fifty patients with chronic constipation were divided into two groups: control and intervention. Only lifestyle changes were applied to the control group, and CTM was applied to the intervention group in addition to lifestyle changes. The intervention group was shown to be more effective than the control group in reducing chronic constipation symptoms and improving quality of life (128). In our study, parameters such as decrease in symptom score and incontinence frequency and increase in voiding volume in the CTM group may have led to an increase in the quality of life of the children. Studies in the literature show that LUTD harms children's quality of life, school performance, family and social life (129,130). We also assume that

reducing children's LUTD symptoms and increasing their quality of life will increase their school success and improve their social relationships in the future.

The study included a few limitations. The first of these is that children in both groups were not evaluated at any time during the 8-week intervention. An interm evaluation would have been more informative in terms of short-term effects. The second limitation is that both the CTG and PFG do not have long-term follow-up results after the intervention. Long-term follow-up results are very important both in interpreting the difference between the two groups and in revealing the effectiveness of the intervention. According to ICCS, for complete success, there should be no recurrence within 2 years after treatment (1). Another limitation of our study is that the CTM examination was performed only on the study group. As a result, no evaluation could be made between the two groups in terms of CTM examination before and after intervention. Another limitation is that the study was not blind and there was no placebo group. Blind studies are more reliable and prevent bias. The placebo group also helps to see the true effect of the interventions.

Our research has many strengths. To the best of our knowledge there are no studies in the literature investigating the effect of CTM in the pediatric population with LUTD. In this sense, our study will contribute to the literature by showing that manual therapy is used in pediatric urinary problems. Furthermore all treatment methods used in our study are conservative options and do not have any side effects. Another strength is the use of scales with validity and reliability by providing a sufficient sample size.

7. CONCLUSION

In conclusion, as far as we know, our study is the first study in the literature that aims to compare CTM applied in addition to PFMR with PFMR alone in children with LUTD. CTM applied in addition to PMFR was more effective on certain uroflow and bladder diary parameters, symptom severity score, quality of life, and certain PFM activation parameters. CTM applied together with PFMR can be preferred in children with LUTD as a non-invasive and accessible manual therapy method.

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APPENDIX A: ETHICAL COMMITTEE APPROVAL

Sayı: 37068608-6100-15- 2496 16.Şubat.2023
Konu: Klinik Araştırmalar
Etik Kurul Başvurusu hk.

Sorumlu Araştırmacı Dr. Öğr. Üyesi Elif Develi
(Yeditepe Üniversitesi, Sağlık Bilimleri Fakültesi Fizyoterapi ve Rehabilitasyon AD., ISTANBUL)

Başvurunuz ve/veya ilgili yazışmalarınız Klinik Araştırmaları Etik Kurulu (KAEK) tarafından değerlendirildi. Etik Kurulumuz, başvuru ve ek bilgileri değerlendirdikten sonra **15 Şubat 2023** tarihli toplantısında **"Alt Üriner Sistem Disfonksiyonu Olan Çocuklarda Konnektif Doku Manipulasyonunun Klinik Semptomlar ve Pelvik Taban Kas Fonksiyonları Üzerine Etkileri"** başlıklı klinik çalışma protokolünüzü ve başvurunuzu onayladı.

Onay bilgileri:

Referans No : 2023/1719
Onay Süresi : Şubat 2023 - Şubat 2024
Yetkili Personel : Fzt. Melis Ünal

Yeditepe Üniversitesi Klinik Araştırmalarda Etik Kuralu Sağlık Bakanlığı, TİTCK Başkanlığın onayı ile oluşturulmuştur. Bu projenin onaylanması, "İlaç ve Biyolojik Ürünlerin Klinik Araştırmaları Hakkında Yönetmeliği, Tıbbi Cihaz Yönetmeliği ve uluslararası etik ilkeler çerçevesinde değerledirilmiştir. Bu araştırmaya ilişkin bir raporun, onay tarihinden itibaren her 12 ayda bir sunulması gerekmektedir. Raporların sunulmaması, projenin devam etmediğinin onayı olarak değerlendirlecektir.

Saygılarımla

Prof. Dr. Turgay Çelik

Klinik Araştırmaları Etik Kurul Başkanı

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APPENDIX B: INFORMED WRITTEN CONSENT

Araştırmanın Adı: Alt Üriner Sistem Disfonksiyonu Olan Çocuklarda Konnektif Doku Manipulasyonunun Klinik Semptomlar ve Pelvik Taban Kas Fonksiyonları Üzerine Etkileri

Ebeveyn için;

Sayın ebeveyn,

Çocuğunuzu yukarıda adı yazılı, Tuğtepe Çocuk Ürolojisi ve Cerrahisi merkezinde gerçekleştirilecek olan araştırmamıza davet ediyoruz. Çalışmaya katılmama veya katıldıktan sonra ayrılma hakkına sahipsiniz. Çalışmaya katılıp katılmama kararı tamamen size ve çocuğunuza aittir ve gönüllülük esasına dayanmaktadır. Katılmak isteyip istemediğinize karar vermeden önce araştırmanın neden yapıldığı, bilgilerinizin nasıl kullanılacağını, çalışmanın neleri içerdiğini, olası yararları ve risklerini ya da rahatsızlık verebilecek yönlerini anlamanız önemlidir. Lütfen aşağıdaki bilgileri dikkatli şekilde okumak için zaman ayırınız. Sorularınız olursa sorunuz ve açık yanıt isteyiniz.

Bu araştırma ile alt üriner sistem disfonksiyonu (AÜSD) olan çocuklarda konnektif doku manipulasyonun (KDM) klinik semptomlar ve pelvik taban kas fonksiyonları üzerine etkilerinin araştırılması hedeflenmiştir. Çalışmamız boyunca katılımcılara herhangi bir girişimsel (iğne, aşı vb.) uygulama yapılmayacaktır. Araştırmamıza Pediatrik Ürolog tarafından AÜSD tanısı almış ve çalışmamıza uygun bulunmuş gönüllü çocuklar dahil edilecektir. Çalışmaya katılmayı gönüllü olarak kabul eden tüm katılımcılara demografik ve klinik özellikleri siz ebeveynlerin de katkısı ile araştırmacılar tarafından hazırlanan Değerlendirme Formu ile sorgulanacaktır. Gün içindeki mesane fonksiyonlarını değerlendirmek amacıyla katılımcılardan ebeveyn gözetiminde 2 Günlük Mesane Günlüğü doldurulması istenecektir. İşeme eğrisi ve parametrelerinin değerlendirilmesi amacıyla Üroflovmetri olarak adlandırılan işeme testi yapılacak, mesanede rezidü idrar kalıp kalmadığı Ultrasonografi yöntemi ile pediatrik ürolog tarafından değerlendirilecektir. Pelvik taban kas aktivasyonu fizyoterapist tarafından EMG'li cihaz ile, AÜSD ciddiyeti İBSS anketi ile, çocukların yaşam kalitesi ise ise PinQ anketi ile değerlendirilecektir. Katılımcılar eşit şekilde iki gruba ayrılacaktır. Birinci gruba 8 hafta boyunca haftada 3 gün Pelvik Taban Kas Rehabilitasyonu (PTKR) ve KDM uygulanacaktır. İkinci gruba ise 8 hafta boyunca haftada 3 gün yalnızca PTKR

uygulacaktır. Araştırma için Yeditepe Üniversitesinden ve Tuğtepe Çocuk Ürolojisi ve Cerrahisi merkezinden izin alınmıştır. Araştırmaya sizin çocuğunuz dışında 30 çocuk daha katılacaktır. Çocuğunuzun bu çalışmaya 8 hafta boyunca, haftada 3 kez düzenli şekilde katılmasını istemekteyiz. Düzenli olarak katılmayan kişiler araştırmadan çıkarılabilmektedir. Bu çalışmanın size, çocuğunuza ve yakınlarınıza herhangi bir zararı olmayacaktır. Bu çalışmaya katılmak için herhangi bir parasal yükün altına girmeyeceksiniz ve size de herhangi bir ödeme yapılmayacaktır. Çocuğunuza bu araştırma hakkında anlayacağı şekilde bilgilendirme yapılacak ve araştırmaya katılımı için rızası alınacaktır.

Bu araştırmaya katılıp katılmamakta tümü ile özgürsünüz. Gerek duyduğunuz tüm bilgileri istemeye ve doğru, açık, anlaşılır bilgi almaya hakkınız vardır. Araştırmaya katılmak istemezseniz burada çocuğunuza verilen hizmeti olumlu ya da olumsuz etkilemeyecektir. Gerekli gördüğünüz durumda araştırmanın herhangi bir kısmında katılımcı araştırmadan çıkabilir, araştırmacı çalışmayı sonlandırabilir. Araştırmanın tüm aşamalarında çocuğunuzun kimlik bilgileri gizli tutulacaktır. Araştırma kapsamında elde edilen bilgiler bilimsel amaçla kullanılabilir, gizlilik kurallarına uymak kaydıyla sunulabilir ve yayınlanabilir.

Araştırma ile ilgili daha fazla bilgiye ihtiyaç duyarsanız araştırma yürütücüsüne

numaralı telefondan ulaşabilirsiniz.

Yukarıda yer alan ve araştırmaya başlamadan önce katılımcılara verilmesi gereken bilgileri içeren metni okudum (ya da sözlü dinledim). Araştırma kapsamında elde edilen çocuğuma ait bilgilerin bilimsel amaçlarla kullanılmasını, gizlilik kurallarına uyarak sunulmasını ve yayınlanmasını, hiçbir baskı ve zorlama altında kalmaksızın kendi özgür irademle kabul ettiğimi beyan ederim.

Çocuk Rıza Formu

Sevgili arkadaşım benim adım Fizyoterapist Melis ÜNAL. Senin yaşlarında olup alt üriner sistem disfonksiyonu olan çocuklar için bir araştırma yapıyoruz. Amacımız, bu çocuklarda uygulanacak olan konnektif doku manipülasyonu ve pelvik taban kas rehabilitasyonunun etkilerini değerlendirmektir. Araştırmamızda yeni şeyler öğreneceğiz. Bu araştırmaya katılmanı öneriyoruz.

Araştırmaya ben, Fizyoterapist Melis ÜNAL, Prof. Dr. Halil TUĞTEPE ve Dr. Öğr. Üyesi Elif DEVELİ ÜSTÜN katılacaktır. Tuğtepe Çocuk Ürolojisi ve Cerrahisi Merkezinde gerçekleşecek bu projemizin adı " Alt Üriner Sistem Disfonksiyonu Olan Çocuklarda Konnektif Doku Manipulasyonun Klinik Semptomlar ve Pelvik Taban Kas Fonksiyonları Üzerine Etkileri". Eğer sen de bu araştırmaya katılmayı istersen senden birkaç anket sorusu cevaplamanı isteyeceğim. Soruları sana okuyacağım ve röportaj yapacağız sonrasında kendine yakın hissettiğin cevabı bana vermeni isteyeceğim. İşeme şeklini ve miktarını belirlemek için bir "işeme testi" yapacağız ve çiş torbamızı tamamen boşaltabiliyor muyuz diye bir cihaz ile kontrol edeceğiz. Daha sonra ise çişini yapmayı sağlayan kasların fonksiyonunu bilgisayar ekranında oyun şeklinde ölçeceğiz. Çiş torbamızla veya çişimizle ilgili yaşadığımız problemlerin ortadan kalkması için bir tedavi uygulayacağız. Bu tedavide senin canını acıtacak, sana zarar verecek hiçbir yöntem olmayacak. Uygulanan bir tedavide çişimizi tutmamızı sağlayan kaslarımızı geliştireceğiz. Diğerinde ise bu kas çalışmasına ek olarak vücudumuza bazı masaj uygulamaları olacak. Bakalım sen hangi gruptaki tedaviyi alacaksın? Bu çalışmada yalnız değilsin senin gibi yaklaşık 30 çocuk daha katılacak. Onları da sana uyguladığım aynı yöntemlerle değerlendirecek ve tedavi uygulayacağım. Tedavimiz toplam 8 hafta sürecek ve senden haftada 3 gün ebeveynlerin ile birlikte bu tedaviye katılmanı isteyeceğim.

Bu araştırmanın toplam sonuçlarını başka doktorlara ve fizyoterapistlere de söyleyeceğiz. Ancak senin adın ve sonuçlarını kimseye açıklamayacağız. Bu araştırma hakkında anne ve babana bilgi vereceğiz ve senin de bu araştırmaya katılman için onlardan izin alacağız. Sen de bu konuyu anne ve/veya baban ile konuşabilirsin. Eğer katılmak istemezsen hiç kimse sana kızmaz veya küsmez. Aklına şimdi gelen veya daha sonra gelecek tüm soruları bana sorabilirsin. Telefon numaramı sana vereceğim. Bu araştırmaya katılmayı kabul ediyorsan lütfen aşağıya adını ve soyadını yazarak imzanı at.

Katılımcının:	**Ebeveyn ya da Veli/Vasinin:**
Adı – Soyadı:	Adı – Soyadı:
Adresi (varsa telefon no) :	Adresi (varsa telefon no) :
İmza ve Tarih:	İmza ve Tarih:

Araştırma Yöneticisinin:

Adı – Soyadı: Fzt. Melis Ünal

Tanık:

Adı – Soyadı:

Adresi (varsa telefon no) :

İmza ve Tarih:

APPENDIX C: DEMOGRAPHIC AND CLINICAL SYMPTOMS QUESTIONNAIRE

Hastanın Adı Soyadı:	**Tarih:**	
Doğum Tarihi:	**Cinsiyet (K-E) :**	
Boy (cm) :		
Kilo (kg) :		
Ebeveyn Telefon No:		
Şikayet:		
Tanı:		
Hikaye:		
İlaç Hikayesi:		
Cerrahi Geçmiş:		
Soygeçmiş:		
Kronik Hastalık:	Evet	Hayır
Mental- Bilişsel Problem :	Evet	Hayır
Nörojenik Problem:	Evet	Hayır
İDRAR YOLU ENFEKSİYONU		
Şu an geçirilen idrar yolu enfeksiyonu var mı?	Evet	Hayır
Geçmişte sık sık idrar yolu geçirme hikayesi var mı?	Evet	Hayır
İşeme Gündüz Bulguları		
Kesikli işeme	Evet	Hayır
İşemeye başlamada zorluk	Evet	Hayır
İşeme öncesi, sırasında ya da sonrası ağrı	Evet	Hayır
İşeme sıklığında azalma	Evet	Hayır

İşeme sıklığında artma	Evet	Hayır
İdrarı boşaltamama hissi	Evet	Hayır
Zayıf akımlı işeme	Evet	Hayır
Ikınarak işeme	Evet	Hayır
Ani işeme hissi (Urgency)	Evet	Hayır
Erteleme Manevraları	Evet	Hayır

İNKONTİNANS SIKLIĞI		
Gündüz inkontinansı var mı ?	**Evet**	**Hayır**
Gündüz İdrar Kaçırma Sıklığı	**Gündüz İdrar Kaçırma Miktarı**	
____________________ gün / ay	Damla damla (1)	
____________________ gün / hafta	İç çamaşırını ıslatacak kadar (2)	
____________________ kere / gün	Pantolonunu ıslatacak kadar (3)	
	Bulunduğu yeri ıslatacak kadar (4)	
Gece inkontinansı var mı?	Evet	Hayır
Gece İdrar Kaçırma Sıklığı	**Gece İdrar Kaçırma Miktarı Miktarı**	
____________________ gün / ay	Damla damla (1)	
____________________ gün / hafta	İç çamaşırını ıslatacak kadar (2)	
____________________ kere / gün	Pantolonunu ıslatacak kadar (3)	
	Bulunduğu yeri ıslatacak kadar (4)	

APPENDIX D: EMG- UROFLOWMETRY

Hasta Bilgileri

Hasta Adı: [redacted]

Doğum Tarihi :

TC Kimlik No :

Barkod No : 0000000

Test Tarihi : [redacted]

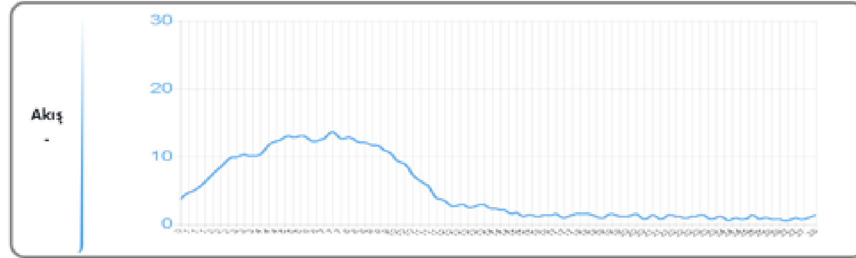
İsteyen Birim : [redacted]

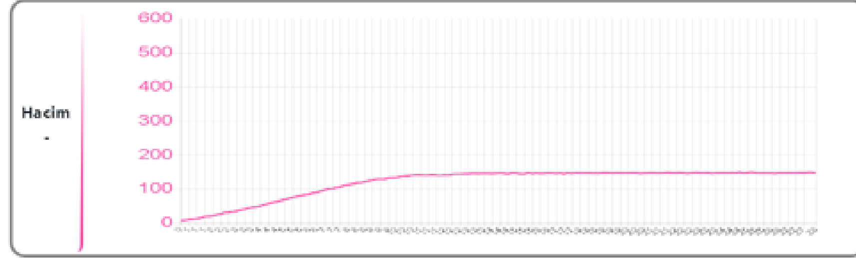
Konsültan Dr. : [redacted]

PMR :

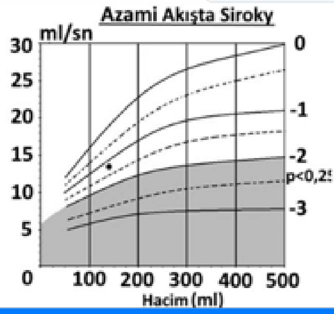
PVR :

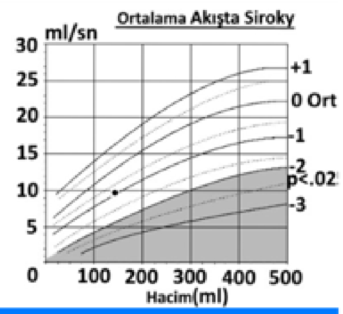
Uroflow Sonuçları





PVR :





Test Özet Bilgileri

Ortalama Akış	10.1 ml/sn
Azami Akış	13.65 ml/sn
Toplam Hacim	149.6 ml
İşeme Süresi	14.81 sn
Azami Akış Zamanı	7.4. sn
Gecikme Süresi	0 sn

APPENDIX E: BLADDER DIARY

2 GÜNLÜK MESANE (İDRAR) GÜNLÜĞÜ

Tedavi algoritmanızın doğru belirlenebilmesi için lütfen günlüğü eksiksiz bir şekilde 2 gün (3. günün ilk idrarı dahil) boyunca doldurunuz. Doldurmakta zorlandığınız noktalarda fizyoterapistiniz ile iletişime geçiniz.

Ad-Soyad:	**Ölçüm İçin Gerekli Malzemeler**	**Günlük toplam alınan sıvı miktarı (ml veya cc) =**
Doğum Tarihi	**1 adet idrar ölçümü için ölçülü kap (ml veya cc)**	**Günlük toplam işenen idrar miktarı (ml veya cc) =**
Günlüğü Doldurma Tarihi	**1 adet sıvı ölçümü için ölçülü kap (ml veya cc)**	**Maksimum işenen idrar miktarı (ml veya cc) =**

ÖRNEK MESANE GÜNLÜĞÜ

İşeme saati & Sıvıyı Alma Saati	***İşeme Miktarı (ml veya cc)***	***İşeme Süresi (saniye)***	***Aciliyet Hissi*** *(Yok/Az/Orta/Çok)*	***İşemeden Önce İç Çamaşırı**** *(1,2 3, 4 puan/Kuru)*	***İdrar Kaçırma Derecesi*(saat başı kontrol)*** *(1, 2, 3, 4 puan)*	***İçilen Sıvı Miktarı ve Türü (ml veya cc)***
Örnek: 09:15 (Sabah yapılan ilk idrar zamanı)	250 ml	12 sn	az	2 puan		
10:00 saat başı					3 puan	
13:15						250 ml süt
14:30	100 ml	8 sn	yok	kuru		400 su
16:20	50 ml	5 sn	orta	1 puan		
20:00	150 ml	10 sn	yok	4 puan	3 puan	100 ml su
Kaçırma ile İlgili Derecesi*	İç çamaşırında bozuk para büyüklüğünde idrar kaçağı (damla damla): ***1 puan*** İç çamaşırı tamamına yakın ıslak: ***2 puan*** Kıyafetine geçecek kadar ıslak: ***3 puan*** Bulunduğu yeri ıslatacak kadar ıslak: ***4 puan***					

APPENDIX F: DYSFUNCTIONAL VOIDING AND INCONTINENCE SCORING SYSTEM (DVISS)

1. Çocuğunuz gündüz idrar kaçırıyor mu ?	Hayır Kaçırmaz	Bazen	Günde 1-2 kez	Her zaman
	0	1	3	5
2. Çocuğunuz gündüz idrar kaçırıyorsa ne şiddette idrar kaçırıyor ?	Damla-damla	Sadece külot ıslak	Pantolon tamamen ıslak	
	1	3	5	
3. Çocuğunuz gece idrar kaçırıyor mu ?	Hayır Kaçırmaz	Haftada 1-2 gece	Haftada 3-5 gece	Haftada 6-7 gece
	0	1	3	5
4. Çocuğunuz gece idrar kaçırıyorsa ne şiddette idrar kaçırıyor ?	Çamaşırı veya Pijaması ıslanır	Yatak ıslanır		
	1	4		
5. Çocuğunuz günde kaç kere tuvalete çiş yapmaya gider?	7 den az	7 den fazla		
	0	1		
6. Çocuğunuz işerken ıkınır mı ?	Hayır	Evet		
	0	4		
7. Çocuğunuz işerken ağrısı olduğunu söyler mi ?	Hayır	Evet		
	0	1		
8. Çocuğunuz işerken bir başlayıp bir durarak çişini yapar mı?	Hayır	Evet		
	0	2		
9. Çocuğunuz çişi bitince tekrar tuvalete gidip çişini yapar mı?	Hayır	Evet		
	0	2		
10. Çocuğunuz aniden çişinin geldiğini söyleyip hızla tuvalete koşuyor mu?	Hayır	Evet		
	0	1		
11. Çocuğunuz oyun sırasında bir kenara diz üstü çöküp idrarını tutmaya çalışıyor mu?	Hayır	Evet		
	0	2		
12. Çocuğunuz çişi geldiğinde tuvalete yetişemeden çişini altına kaçırıyor mu?	Hayır	Evet		
	0	2		
13. Çocuğunuzun kabızlığı var mı?	Hayır	Evet		
	0	1		
HAYAT KALİTESİ				
Çocuğunuzda yukarıda sayılan şikayetlerden bir veya birkaçı varsa bu aile, okul ve sosyal yaşantısını ne kadar etkiliyor?	Hayır Etkilemiyor	Evet az etkiliyor	Evet etkiliyor	Evet ciddi etkiliyor
	0	1	2	3

APPENDIX G: PEDIATRIC URINARY INCONTINENCE QUALITY IF LIFE SCORE (PIN-Q)

PIN-Q(TR)

ÜRİNER İNKONTİNANSLI ÇOCUKLARDA YAŞAM KALİTESİ ÖLÇEĞİ

Merhaba!

Senden geçen hafta boyunca neler hissettiğini öğrenmek istiyoruz ve bu amaçla yanıtlamanı istediğimiz bir kaç soru hazırladık.

⇨ Şimdi sana soruları okuyacağım.

⇨ Geçen hafta boyunca seninle ilgili neler olduğunu düşünmeni istiyorum.

Daha sonra da,

⇨ sana en uygun gelen yanıtı bana söylemeni istiyorum.

Doğru veya yanlış yanıt yoktur. Sadece senin ne düşündüğün önemli.

Doldurma tarihi: __ / __ / __ (gün / ay / yıl)

Lütfen bana biraz kendinden söz eder misin?

Sen bir kız mısın yoksa oğlan mı? ☐ kız ☐ oğlan

Kaç yaşındasın ? _______ yaşındayım

Kaç kardeşin (erkek, kız kardeşin veya ablan, abin) var?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 5 den fazla

Bir ana okuluna veya kreşe gidiyor musun?

☐ evet ☐ hayır

Hadi şimdi ankete başlayalım.

Sana uygun olan yanıt seçeneğine ait rakamı lütfen daire içine al.

S1	Mesane problemimden dolayı utanıyorum	Hayır	Hemen hemen hiç	Bazen	Sık sık	Her zaman
S2	Ailem mesane problemim nedeniyle bana farklı davranıyor	0	1	2	3	4
S3	İnsanların elbiselerimin çiş koktuğunu düşünmelerinden endişe ediyorum	0	1	2	3	4
S4	Mesane problemimin iyileşmeyeceğini düşünüyorum	0	1	2	3	4
S5	Annem ve babam mesane problemim nedeniyle benim için endişeleniyorlar	0	1	2	3	4
S6	Mesane problemim olmasaydı kendimi daha iyi hissederdim	0	1	2	3	4
S7	Mesane problemim nedeniyle kendimi sinirli hissediyorum	0	1	2	3	4
S8	Mesane problemimden dolayı annem babam bazen biraz aksi oluyorlar	0	1	2	3	4
S9	Mesane problemim tatile gitmeme ve bir yerde yatıya kalmama engel oluyor	0	1	2	3	4
S10	Mesane problemim kendimi kötü hissetmeme neden oluyor	0	1	2	3	4

S11	Mesane problemim nedeniyle uykumdan uyanıyorum	Hayır	Hemen hemen hiç	Bazen	Sık sık	Her zaman
S12	Mesane problemimden dolayı bazı şeyleri kaçırıyorum	0	1	2	3	4
S13	Mesane problemimden dolayı kendimi mutsuz hissediyorum	0	1	2	3	4
S14	Mesane problemim beni üzüyor	0	1	2	3	4
S15	Oynayacağım sporu mesane problemimi düşünerek seçiyorum	0	1	2	3	4
S16	Film seyrederken tuvalete gitmek zorunda kalıyorum	0	1	2	3	4
S17	Eğer mesane problemim düzelseydi evime daha çok arkadaş davet ederdim.	0	1	2	3	4
S18	Kendime, sık sık tuvalete gitmemden etkilenmeyecek hobiler seçiyorum	0	1	2	3	4
S19	Mesane problemim beni diğer insanlardan farklı hissetmeme neden oluyor	0	1	2	3	4
S20	Mesane problemimden dolayı arkadaşlarımla beraber olamıyorum.	0	1	2	3	4

APPENDIX H: PHOTO PERMISSION

Araştırmanın Adı: Alt Üriner Sistem Disfonksiyonu Olan Çocuklarda Konnektif Doku Manipulasyonunun Klinik Semptomlar ve Pelvik Taban Kas Fonksiyonları Üzerine Etkileri

Ebeveyn için;

Sayın ebeveyn,

Çocuğunuzu yukarıda adı yazılı, Tuğtepe Çocuk Ürolojisi ve Cerrahisi merkezinde gerçekleştirilecek olan araştırmamızda fotoğraflarının kullanımı için davet etmekteyiz. Fotoğraflarda çocuğunuzun yüzü gözükmeyecektir. Fotoğraflar başka hiçbir amaç için kullanılmayacaktır.

Katılımcının:
Adı – Soyadı:
Adresi (varsa telefon no) :
İmza ve Tarih:

Ebeveyn ya da Veli/Vasinin:
Adı – Soyadı:
Adresi (varsa telefon no) :
İmza ve Tarih:

Araştırma Yöneticisinin:
Adı – Soyadı: Fzt. Melis Ünal
Adresi (varsa telefon no) :
İmza ve Tarih:

Tanık:
Adı – Soyadı:
Adresi (varsa telefon no) :
İmza ve Tarih:

APPENDIX I: CURRICULUM VITAE

Kişisel Bilgiler

Adı	Melis	**Soyadı**	ÜNAL

Öğrenim Durumu

Derece	Alan	Mezun Olduğu Kurumun Adı	Mezuniyet Yılı
Doktora			
Yüksek Lisans			
Lisans	Fizyoterapi ve Rehabilitasyon	**Yeditepe Üniversitesi**	2021
Lise	Matematik-Fen	**Dr. İlhami Tankut Anadolu Lisesi**	2016

Bildiği Yabancı Dilleri	**Yabancı Dil Sınav Notu (#)**
İngilizce	YÖKDIL: 93

İş Deneyimi (Sondan geçmişe doğru sıralayın)

Görevi	**Kurum**	**Süre (Yıl - Yıl)**
Fizyoterapist	Uropelvic Solutions Pelvik Taban Rehabilitasyon Merkezi	2021- Halen-
		-

Bilgisayar Bilgisi

Program	**Kullanma becerisi**
Microsoft Office	Iyi

APPENDIX J: THESIS CONTROL LIST

Tezi son haline getirip çoğaltmadan önce aşağıdaki kontroller yapılmalıdır

☒ Kapak ve iç kapak sayfalarında YÜKSEK LİSANS veya DOKTORA şeklinde elde edilen unvanlar yazıldı (Kapak sayfasına danışman adı yazılmamalıdır).

☒ Kapak sayfasına mezun olunan PROGRAMIN (Anabilim dalının değil) adı yazıldı.

☒ Tez kapağı sırt kısmına kılavuzda belirtilen şekilde (yazının yönüne dikkat!) ad-soyad, enstitünün adı, program, yıl yazıldı.

☒ Kapakta yalnız tez başlığı 18 punto ve koyu renk, Enstitü ve Anabilim Dalı 14 punto ve diğer yazılar 12 punto ile yazıldı.

☒ Onay sayfası uygun şekilde hazırlandı (kazanılan unvanlar YÜKSEK LİSANS veya DOKTORA olmalıdır), imzalatıldı (Enstitü Müdürü'nün imzası da gereklidir, imzaların aynı renk kalemle atılmasına dikkat edilmelidir).

☒ Çıktılar kaliteli çıktı veren bir bilgisayar kullanılarak, kâğıdın tek yüzüne alındı.

☒ Dizinler kılavuzda belirtildiği gibi sıralandı.

☒ Ön sayfalara i, ii, iii şeklinde Roma rakamları konuldu.

☒ Sayfa numaraları kılavuzda belirtildiği şekilde konuldu.

☒ Sayfa düzeni kılavuzda belirtildiği şekilde yapıldı.

☒ Ana metin Times New Roman yazı tipi ile harf büyüklüğü 12 punto olacak şekilde basıldı.

☒ Dipnot harf büyüklüğü 8-10 punto olacak şekilde basıldı.

☒ Ana metin satır aralığı 1.5 olacak şekilde yazıldı.

☒ Türkçe ve İngilizce özet birbiri ile uyumlu olarak yazıldı.

☒ Türkçe ve İngilizce özete uygun anahtar kelimeler konuldu.

☒ Kısaltma ve semboller uygun şekilde yapıldı.

☒ Kaynaklar listesinde, her kaynağa numara verildi. Kaynak gösterme ilkelerine ve künye kurallarına uygun şekilde yazıldı.

☒ Tezde kullanılan bütün kaynaklar temin edildi.

☒ Ekler uygun başlıklarla, tezdeki sunuş sırasına göre, ayrı sayfalardan başlamak üzere verildi.