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PELVIC FLOOR MUSCLE FUNCTION IN 5 DIFFERENT POSITIONS IN CHILDREN

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ABSTRACT

Purpose: There is little information in the literature regarding the functional activity of the pelvic floor muscles (PFM) in children in both physiological and pathological conditions. In this study, we aimed to investigate the resting and functional bioelectrical activities of PFM in 5 different positions (supine, prone, sitting, side lying, standing).
Methods: Twenty-five children with lower urinary tract symptoms (LUTS) were included in the study. Pelvic floor muscle activity (PFMA) was measured using surface electrodes in the postvoid period, which is the resting phase of the pelvic floor muscles. During the measurement, 5 seconds of contraction and 5 seconds of relaxation were performed, and the average values of the 50-second period were recorded.
Results: The best relaxation was observed in the supine position and was 1.43 ± 0.80 mV. The weakest relaxation was observed in the standing position and was statistically significantly inadequate in supine, prone, side lying and sitting positions (p=0.001; 0.001; 0.001; 0.001 respectively). Contraction was best achieved in the standing position, but a statistically significant difference was found in the supine and sitting position (p=0.009; 0.006 respectively). The weakest contraction was in the sitting position.
Discussion: PFM relaxation in children is best achieved in the supine position and may be important in the treatment of dysfunctional voiding children. We think that the weakest relaxation and strongest contraction in the standing position is due to the effect of gravity.
Key Words: children, electromyography, pelvic floor, posture

ÖZET

Amaç: Çocuklarda pelvik taban kasları (PTK)'nın fizyolojik ve patolojik durumlarda fonksiyonel aktivitesi ile ilgili literatürde çok az bilgi söz konusudur. Bu çalışmada 5 farklı pozisyonda (sırtüstü, yüzüstü, oturma, yan yatış, ayakta) PTK'nın istirahat ve fonksiyonel biyoelektrik aktivitelerini araştırmayı amaçladık.
Yöntem: Kliniğimize alt üriner sistem semptomları (AÜSS) ile başvuran 25 çocuk çalışmaya alındı. Pelvik taban kaslarının istirahat fazı olan işeme sonrası dönemde yüzeyel elektrodlar kullanılarak pelvik taban kas aktivitesi (PTKA) ölçüldü. Ölçüm esnasında 5 saniye kasılma ve 5 saniye gevşeme yaptırılarak 50 saniyelik periyodun ortalama değerleri kaydedildi.
Bulgular: En iyi gevşeme sırtüstü pozisyonda izlendi ve 1,43 ± 0,80 mV idi. En zayıf gevşeme ayakta pozisyonda izlendi ve sırtüstü, yüzüstü, yan yatış ve oturma pozisyonlarından istatistiksel anlamlı olarak yetersizdi (p=0,001; 0,001; 0,001; 0,001, sırasıyla). Kasılma en iyi ayakta sağlandı ve sırtüstü ve oturma pozisyonları ile arasında istatistiksel olarak anlamlı fark bulundu (p=0,009; 0,006). En zayıf kasılma oturur pozisyonda idi.
Tartışma: Çocuklarda PTK gevşemesi en iyi sırtüstü pozisyonda sağlanmaktadır ve disfonksiyonel işeyen çocukların tedavisinde önemli olabilir. En zayıf gevşemenin ve en kuvvetli kasılmanın ayakta pozisyonda sağlanmış olmasını yer çekiminin yaptığı etkiye bağlı olduğunu düşünüyoruz.
Anahtar Kelimeler: çocuk, elektromiyografi, pelvik taban, postür

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INTRODUCTION

The functions of the pelvic floor muscles (PFM) include supporting the abdominal and pelvic organs, maintaining anal and urinary continence, working in coordination with the thoracic diaphragm and abdominal muscles to maintain intra-abdominal pressure, and assisting in respiration and trunk stabilization (1). These functions are achieved through the contraction and relaxation of the pelvic floor muscles (2). Unlike other striated muscles, pelvic floor muscles possess electrical activity even at rest, this activity is known as basal tonus (3). The tone of the pelvic floor muscles plays a crucial role in regulating these functions (4). By coordinating the level of contraction, the PFM ensures urinary and fecal continence and relaxes during urination and defecation. Increased muscle tone and difficulties in relaxation can disrupt these functions, leading to dysfunctional voiding, urinary incontinence, constipation, and fecal incontinence in children, ultimately affecting their quality of life (5). It has been shown in healthy children that pelvic floor muscles can be activated independently of associated hip and abdominal muscle groups (6).

The body position has a significant effect on the activity of the pelvic floor muscles (7). It has been stated that three criteria, including pressure, duration, and position, should be used when assessing pelvic floor muscle strength. (8) In the application of pelvic floor muscle rehabilitation, the excessive activity or motor coordination of the muscles should be assessed to determine the position of the exercise to be recommended (9). However, electromyography (EMG) measurements of pelvic floor muscles in children with different dysfunctions, as well as biofeedback interventions using EMG for rehabilitation, are limited in the literature (10-12). While various studies have examined the relationship between pelvic floor muscles and different body positions, there is limited information available on the functional activity of these muscles in children. This study aims to investigate the electromyographic activity of the pelvic floor muscles in five different positions (supine, prone, sitting, side-lying, standing) following pelvic floor muscle rehabilitation in children with lower urinary tract symptoms (LUTS).

METHODS

This study was approved by the Atılım University Human Research Ethics Committee on December 18, 2023, with the decision number 604.01.02.-140. The study was conducted in accordance with the Helsinki Declaration.

This descriptive, cross-sectional, and retrospective study included children aged 5-18 who presented to a pediatric urology specialist with lower urinary tract symptoms (LUTS) and underwent pelvic floor rehabilitation. Children with urinary tract infections, neurological, orthopedic, or psychiatric comorbidities were excluded from the study. A standardized treatment protocol consisting of 10 sessions was administered to the children. The protocol was individualized based on the specific lower urinary tract dysfunctions of the children. Pelvic floor muscle measurements were taken for each child at the end of the treatment protocol. Evaluations of the 25 children included in the study were recorded, and their data were analyzed.

Evaluation of pelvic floor muscle activity using surface electromyography

The activities of the PFM in children were assessed using the NeuroTrac Myoplus 4, Verity Medical Ltd, UK, according to the PFMA measurement protocol (13). During the assessment, consent was obtained from both the family and the child. Before the assessment, participants were asked to empty their bladders and rectums. Participants were instructed to squeeze and lift the physiotherapist's fingers placed in the perianal area before the assessment began. Through this method, an experienced physiotherapist taught isolated pelvic floor muscle contraction. Two surface electrodes were placed in the perianal area at the 2 and 7 o'clock positions, and the reference electrode was placed on the inner part of the right thigh. PFMAs were measured in 5 different positions (supine, prone, unsupported sitting, side-lying, standing) for the participants. Care was taken in cable placements to prevent artifacts. When the device gave a "work" audible command, the child was instructed to maintain maximum contraction for 5 seconds, followed by a "rest" command to completely relax the muscle. Along with the audible command, after 10 cycles of contraction and relaxation, the device recorded the 50-second average results of contraction ("work average") and relaxation ("rest average") EMG activities in microvolts (μV).

The contraction and relaxation sets were performed in the same order for each patient in all five positions. Measurements were repeated three times in each position, and the average of the three measurements was recorded. A 2-minute rest interval was provided between positions to prevent muscle fatigue. To minimize error, the physiotherapist standardized the instructions given to the patients. Participants were instructed to look straight ahead, breathe normally, and refrain from moving or speaking. In the supine and prone positions, the head and neck were supported in a neutral alignment with a pillow. The arms were placed freely and parallel to the body, while the legs were positioned straight and slightly abducted. In the side-lying position, the head and neck were supported in a neutral alignment with a pillow, the hips and knees were in a slight flexion, and the feet were aligned with the body. In the sitting position, participants were seated upright without back support, with the pelvis in a neutral position perpendicular to the ground. Participants were instructed to maintain an upright posture. In the standing position, the body was aligned with the head and neck in a neutral position, and the shoulders were relaxed and level. The arms were positioned naturally and parallel to the body. The pelvis was in a neutral alignment with the hips level, and the legs were straight with the feet positioned hip-width apart and parallel to each other. Participants were asked to sit upright. During the measurement, the neutral position of the pelvis was maintained, and movements of the upper body and extremities were not allowed. The test was conducted in a private room in the clinic, with at least one parent present with the children.

The electromyographic signal was recorded by the NeuroTrac Myoplus 4 (Verity Medical Ltd, UK) dual-channel surface EMG device integrated with computer software for digital analysis and report generation. It has been stated that the device's features meet the requirements specified in the publications of the International Society of Electrophysiology and Kinesiology (ISEK) and surface EMG for the non-invasive assessment of muscles.

Statistical Analysis

Statistical analyses were conducted using SPSS 16.0. Descriptive statistics provided insights into the central tendencies and variability of the data. The normality of the data was assessed using the Shapiro-Wilk test. As the normality test indicated a deviation from a normal distribution, non-parametric tests were applied. Given that five different positions were recorded from the same child, the Friedman test was utilized. Positions were identified using the Bonferroni correction. Pairwise comparisons between positions were performed using the Wilcoxon rank test. A post hoc power analysis was conducted using G*Power 3.1.9.7 to determine the achieved power for a Wilcoxon signed-rank test (matched pairs). The effect size, with an 80% confidence interval, was calculated to be 23 participants. A p-value of 0.05 was considered statistically significant.

RESULTS

Twenty-five children, with an average age of 9.72±2.83 years (range 5 to 18), were included in the study. Among the 25 children, 10 were reported to be girls and 15 were boys. The mean±SD values of pelvic floor muscle activity (PFMA) during contraction and relaxation periods in supine, prone, side-lying, sitting, and standing positions in children are presented in Table-1 and Figure-1. The best relaxation was observed in the supine position, which was 1.43 ± 0.8 μV. The highest contraction and the least relaxation were observed in the standing position, which 2.95 ± 1.6 μV and 11.64 ± 6.9 μV, respectively. The least effective contraction was detected in the sitting position, which was 7.92 ± 4.2 μV.

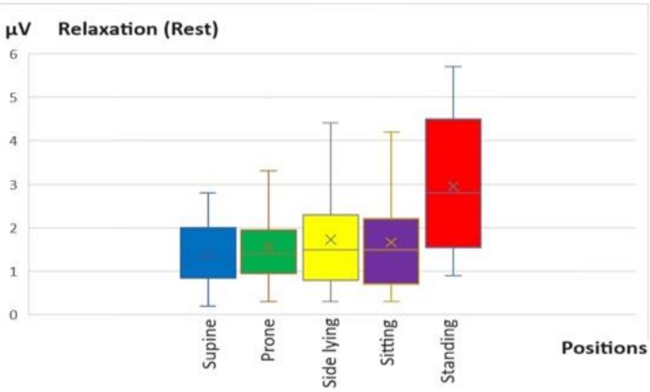
In the pairwise comparison of positions, statistically significant less relaxation was observed in the standing position compared to all other positions (Table 2).

Table 1: Measured pelvic floor muscle activity at relaxation and at the contraction for all examined positions

	Mean±SD		Median (95% Confidence Interval for Mean Lower Bound-Upper Bound)	
Positions	**Relaxation µV**	**Contraction µV**	**Relaxation µV**	**Contraction µV**
Supin	1.43 ± 0.82	8.32 ± 43	1.30 (1.11-1.74)	7.10 (6.67-9.96)
Prone	1.57 ± 16	9.56 ± 4.27	1.40 (1.14-1.99)	8.9 (7.32-11.30)
Side-Lying	1.73 ± 1.23	7.92 ± 4.21	1.66 (1.23-2.08)	8.33 (7.70-11.8)
Sitting	1.66 ± 15	9.47 ± 4.92	1.50 (1.23-2.21)	6.5 (5.89-9.32)
Standing	2.95 ± 1.64	11.64 ± 6.93	2.80 (2.29-3.60)	9.00 (8.85-14.51)

SD: standard deviation

Figure 1: Relaxation and contraction values according to different positions



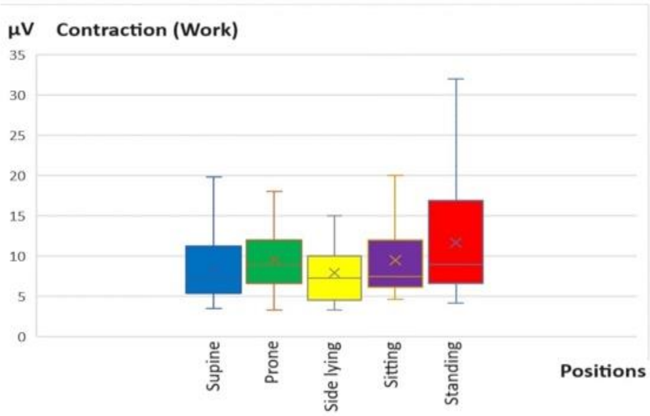


Table 2. p values of pairwise comparisons of positions during relaxation and contraction. Comparisons made by Wilcoxon Ranks test.

p values of pairwise comparisons during relaxation	**Prone**	**Sitting**	**Side Lying**	**Standing**
Supine	0.557	0.085	0.257	0.009
Prone		0.403	0.467	0.001
Sitting			0.808	0.001
Side Lying				0.001
p values of pairwise comparisons during contraction	**Prone**	**Sitting**	**Side Lying**	**Standing**
Supine	0.072	0.306	0.132	0.009
Prone		0.078	0.840	0.203
Sitting			0.062	0.006
Side Lying				0.205

$p<0.05$

During the contraction phase, pairwise comparisons revealed statistically significant differences between the standing and sitting positions, as well as between the standing and supine positions (Table 2).

DISCUSSION

Little is known about the control of the pelvic floor in children and at what ages these specific functions develop. Improved understanding of methods for assessing pelvic floor muscle function in children enhances both evaluation and rehabilitation processes (14). There are few studies on pelvic floor muscle activity in children in different positions (6, 15). In our study, we evaluated the contraction and relaxation understanding of methods for assessing pelvic floor muscle function in children enhances both evaluation and rehabilitation processes (14). There are few studies on pelvic abilities of the pelvic floor muscles in 2 gravity dependent positions (standing and sitting) and 3 gravity independent positions (supine, prone, and side-lying) in children with lower urinary tract dysfunction. The best relaxation was observed in the supine position, the best contraction with the worst relaxation was achieved in the standing position, and the worst contraction recorded in the sitting position.

Wennergren et al. found differences in the degree of pelvic floor muscle activity in different sitting positions on the toilet in girls. It has been shown that optimal relaxation of the pelvic floor muscles can be achieved with adequate knee support. The least relaxation was found in positions without knee support, with the hip and knee in flexion. This has been indicated to be significant in girls for urination techniques, biofeedback, clean intermittent catheterization, and urodynamic practices. It is also emphasized as important for designing pelvic floor exercises for girls (4).

Sollini et al. reported that pelvic floor rehabilitation exercises given as home exercises in the side-lying position and on a fitball were compared in children with LUTD (15). The authors stated that the most crucial aspect, regardless of body position, is training the pelvic floor muscles according to the Kegel theory. It has been mentioned that when performing pelvic floor muscle exercises in a sitting position on a Fitball, it is difficult to control whether the movement is performed correctly due to the direct contact of the pelvic floor muscles with the ball. Similarly to our study, the pelvic floor muscle contraction is weakest in the sitting position in children. We believe this may guide biofeedback studies starting in the sitting position. Dysfunctional voiding, characterized by increased pelvic floor muscle contraction during urination, is a common subtype of LUTD in children. The primary treatment for this condition is biofeedback therapy, which aims to achieve pelvic floor muscle relaxation. The effectiveness of biofeedback therapy for pelvic floor muscle (PFM) is likely affected by the ability of the PFM to contract and relax effectively. Therefore, biofeedback therapy should be conducted in positions that facilitate optimal PFM contraction and relaxation. However, biofeedback therapy for children with LUTD is typically performed in the child's usual sitting position.

Since the standing position is directly affected by gravity, the basal tone of the pelvic floor muscles is the highest (16, 17). Studies in adults have found that pelvic floor muscle activity increases while sitting and further increases in the standing position (17-20). A high center of gravity and a small base of support make it difficult to maintain balance against gravity. Many trunk stabilization muscles are used to maintain posture in this unbalanced state (21). Trunk stabilization muscles and pelvic floor muscles work together in posture balance. Our study, in line with the literature, found that pelvic floor muscle activation increases, and relaxation decreases in the standing position. Adding PFM exercises to standing positions introduces a dual-task situation that complicates coordination. If there is weakness or a lack of coordination in PFM, maintaining positions can exacerbate coordination disorders (7).

The supine position, having a wider base of support and a lower center of gravity, is more stable than standing or sitting positions (22). It has been suggested in adults that starting pelvic floor muscle exercises in the supine or prone position and then progressing to sitting or standing positions is important (7). The transition to standing positions should be delayed until PFM contraction can be performed without auxiliary muscle activities (7). Applications in children vary; therefore, we believe specifying the exercise positions and their sequence in studies may be important for treatment efficacy.

Pelvic floor muscles show different pathologic findings in children with dysfunctional voiding and overactive bladder. Previously, we showed that the main characteristic finding of children with DV on PFMA is the increased rest activity. It means that children with DV could not relax of PFM not only during the voiding phase but also filling phase of LUT (13). Pelvic floor muscles are also affected in children with overactive bladder. Fatigue occurs in the pelvic floor muscles of the child with overactive bladder, who has to constantly contract her pelvic floor muscles in order to avoid urinary incontinence due to excessive bladder activity throughout the day. In our previous study, we found that there is no problem in relaxation in children with overactive bladder, but contraction function is impaired and especially the inability to continue contraction, which known as low endurance of PFM (8). All these findings show us that there are different dysfunction in the PFMs in different lower urinary tract dysfunctions. Therefore, the primary treatment in children with dysfunctional voiding is biofeedback therapy, which is a component of pelvic floor rehabilitation (23). We think that determining which position is more suitable for better rehabilitation during these treatments will be effective in the success of the treatment.

The magnitude of pelvic floor muscle activity in children varies depending on the position. Therefore, it is important to note the position. Pelvic floor muscle activity measured with different methods in the same positions can exhibit variability (24) Even when measured in the same positions using the same method, different results can be obtained in different patient groups, such as patients and healthy controls, males and females, children and adults (24).

Limitation

The limitations of our study include a small sample size, lack of differentiation by gender and age groups, and the absence of a control group. Randomized controlled trials are needed in healthy children.

CONCLUSION

It is considered that treatment should start in the supine position for children presenting with LUTS and requiring pelvic floor muscle rehabilitation, and then progress to sitting and standing positions.

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