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Original Article

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# Biofeedback therapy for dysfunctional voiding and giggle incontinence in children

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## Abstract

**Objectives:** This study aimed to investigate and compare the effectiveness of biofeedback (BF) therapy in the treatment of dysfunctional voiding (DV) and giggle incontinence (GI).

**Patients and Methods:** Between December 2022 and June 2025, medical records of patients who received BF therapy for DV or GI were retrospectively evaluated. Demographic and clinical data were recorded. Treatment success was evaluated as recommended by the International Children's Continence Society: No treatment response (0-49% improvement), partial treatment response (50-99% improvement), and complete treatment response (100% improvement). The success of BF therapy was compared in both diagnostic groups.

**Results:** A total of 60 patients completed biofeedback therapy, including 43 with DV (10 male, 33 female; mean age: 8.8 ± 3.1 years; range, 5 to 17 years) and 17 with GI (7 male, 10 female; mean age: 8.7 ± 3.0 years; range, 5 to 16 years). The overall complete treatment response was 68.3% (n = 41), and the partial treatment response was 20.0% (n = 12). Treatment success of DV and GI were similar (complete response: 67.4% *vs.* 70.6%, partial response: 20.9% *vs.* 17.6%) ($p > 0.05$). There was no significant difference between age and sex in terms of treatment success ($p > 0.05$ for both). Age, sex, and diagnosis revealed no association in predicting treatment efficacy or complete response in multinomial and binary logistic regression models ($p > 0.05$).

**Conclusion:** Biofeedback therapy demonstrated high and comparable success rates in children with DV and GI. Neither age nor sex was significantly associated with treatment response, supporting the potential role of BF in the management of both conditions.

***Keywords:*** Biofeedback, dysfunctional voiding, giggle incontinence.

Lower urinary tract disorders are common clinical conditions in childhood that significantly impact quality of life. One such disorder, dysfunctional voiding (DV), arises from impaired coordination during the bladder's filling and emptying phases. This condition is characterized by difficulties or interruptions in urination, which occur due to a lack of necessary coordination between the detrusor muscle and the urethral sphincter, as well as the pelvic floor muscles,[1] where the sphincter may remain involuntarily contracted. Dysfunctional voiding can lead to complications, potentially resulting in recurrent urinary tract infections, bladder and bowel dysfunction, and even damage to the upper urinary system.[2]

Giggle incontinence (GI), another urinary issue observed in childhood, is characterized by involuntary, uncontrollable, complete, or near-complete bladder emptying that typically occurs in healthy children during spontaneous laughter, caused by the involuntary relaxation of the pelvic floor muscles.[3] The precise etiology of GI remains inadequately defined; however, pelvic floor control deficiency and the underdevelopment of neuromuscular mechanisms are commonly referenced contributors.[4]

Biofeedback (BF) therapy is a non-invasive approach that is gaining recognition in the conservative treatment of urinary disorders in children and is generally well-accepted by them. This

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therapy helps children gain a better understanding of their pelvic floor muscles, recognize muscle activity, and learn how to appropriately relax and contract different muscle groups.[5]

Evidence regarding BF therapy in children with GI is limited, and comparative studies with DV are scarce. Therefore, we aimed to evaluate the effectiveness of BF therapy in children diagnosed with DV and GI while comparing the treatment responses between these two patient groups. In this context, our study seeks to enhance the existing literature and inform clinical practice.

## PATIENTS AND METHODS

This retrospective comparative observational study was conducted at Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital, Department of Pediatric Urology between December 2022 and June 2025. Written informed consent was obtained from all patients' legal guardians. The study protocol was approved by the Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital Ethics Committee (Date: September 24, 2025, No: 2025/326). The study was conducted in accordance with the principles of the Declaration of Helsinki. Medical records of pediatric patients who underwent BF therapy for DV and GI were evaluated retrospectively. Patients were included if they met the diagnostic criteria for DV or GI set forth by the International Children's Continence Society (ICCS). Conversely, patients exhibiting anatomical anomalies, underlying neurological disorders, incomplete data, cessation of BF, and those who fully responded to urotherapy were excluded from the study (Figure 1). In this context, patients with DV exhibited intermittent or gradual reduction of electromyography (EMG) activity during voiding, along with staccato or intermittent voiding patterns on at least two uroflowmetry (UF) studies prior to diagnosis. Comprehensive histories and physical examinations, including neurological assessments, were extracted from patient files. Data regarding age, sex, diagnosis, and treatment response status were collected and analyzed.

During the initial clinic visit, all patients underwent standard urotherapy. This regimen included hydration recommendations, education on proper postural techniques during urination, implementation of timed voiding every two hours, avoidance of detrusor stimulants such as coffee and tea, and training in bowel management. Constipation was addressed prior to the first BF session. Some patients in the DV group had concomitant symptoms of overactive bladder. These patients were classified according to their primary diagnosis of DV. Anticholinergics were prescribed alongside urotherapy for children diagnosed with overactive bladder. Biofeedback therapy was offered to patients with DV and GI who did not respond to standard urotherapy.

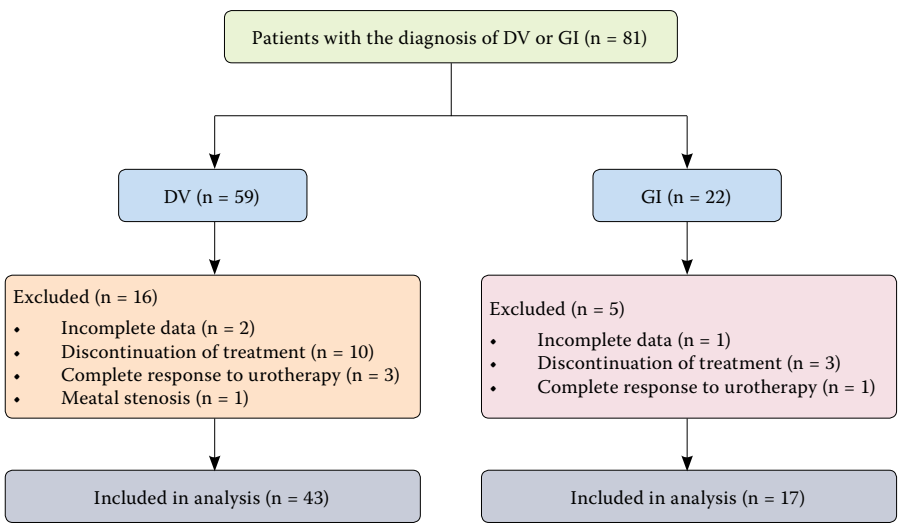



**Figure 1.** Flowchart of patient selection.
DV, dysfunctional voiding; GI, giggle incontinence.

Before commencing BF sessions, the anatomical and functional principles of voiding were explained to both the children and their parents, using illustrative pictures and figures. The Medical Measurement System (MMS; Solar Intelligent Urodynamics, Medical Measurement Systems B.V., Enschede, the Netherlands) was utilized during BF sessions. Two EMG electrodes were positioned at the 3 and 9 o'clock positions on the pelvic floor, with a reference electrode placed on the anterior thigh. Patients were educated about pelvic floor muscle function using animated figures and instructed on how to relax their external urethral sphincters during sessions. Each BF session lasted 15 to 20 min. Biofeedback therapy was scheduled twice weekly for a total of eight sessions, followed by monthly maintenance sessions for three months.

The success of BF therapies was assessed at the conclusion of maintenance sessions. Clinical success in DV was defined as the cessation of EMG activity, accompanied by symptom resolution and improvements in UF parameters. For patients with GI, success was evaluated by quantifying the monthly frequency of their GI complaints. Following the recommendations of the ICCS, outcomes were classified into three categories: "no response" (less than 50% reduction in symptoms), "partial response" (50 to 99% reduction in symptoms), and "complete response" (100% reduction in symptoms).[5]

### Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA), with $p < 0.05$ considered significant. Continuous variables were expressed as the mean ± standard deviation (SD), while categorical variables were expressed as numbers and frequencies. The normality of the numerical data was assessed using the skewness and kurtosis test, supported by visual inspection of histograms and Q-Q plots. The one-way ANOVA test was used to evaluate the relationship between age and treatment response. An independent samples t-test was performed to compare age and diagnosis. Categorical variables were analyzed with Fisher's exact test. Multinomial logistic regression analysis was conducted to identify the predictive factors for treatment success. Furthermore, treatment responses were classified as either complete response or partial/no response, and potential predictors of treatment response were examined using a binary logistic regression model. Odds ratios (ORs) with 95% confidence intervals (CIs) were reported.

## RESULTS

A total of 60 patients were treated with BF therapy, including 43 patients with DV (10 male, 33 female; mean age: 8.8 ± 3.1 years; range, 5 to 17 years) and 17 patients with GI (7 male, 10 female; mean age: 8.7 ± 3.0 years; range, 5 to 16 years). Overall, 43 patients (71.7%) were female and 17 (28.3%) were male. There were no statistically significant differences between the DV and GI groups in terms of sex distribution ($p = 0.209$) or mean age ($p = 0.830$), as shown in Table 1. The overall complete treatment response was 68.3% (n = 41), while the partial treatment response was 20.0% (n = 12). Additionally, 11.7% of all patients (n = 7) were identified as non-responders

**TABLE 1**
Demographics, clinical characteristics, and treatment outcomes of patients

| | DV group | | | | GI group | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | n | % | Mean ± SD | Range | n | % | Mean ± SD | Range | *p* |
| Age (year) | | | 8.8 ± 3.1 | 5-17 | | | 8.7 ± 3.0 | 5-16 | 0.83** |
| Sex | | | | | | | | | 0.209* |
| Female | 33 | 76.7 | | | 10 | 58.8 | | | |
| Male | 10 | 23.3 | | | 7 | 41.2 | | | |
| Treatment response | | | | | | | | | 1.00* |
| Complete | 29 | 67.4 | | | 12 | 70.6 | | | |
| Partial | 9 | 20.9 | | | 3 | 17.6 | | | |
| Non-response | 5 | 11.6 | | | 2 | 11.8 | | | |

DV, dysfunctional voiding; GI, giggle incontinence; SD, standard deviation; *, Fisher's exact test; **, Independent samples t-test.

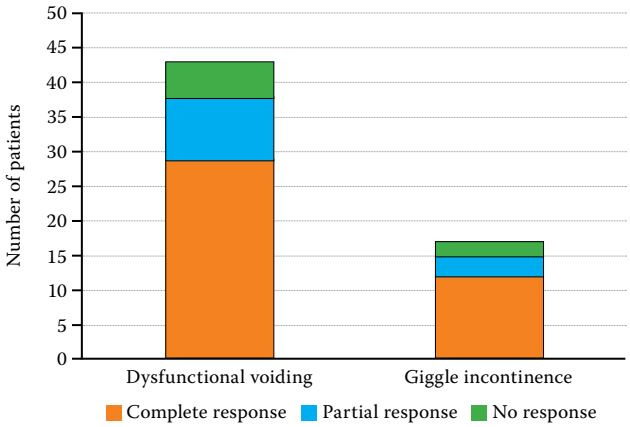



**Figure 2.** Distribution of treatment responses by diagnosis.

to treatment. There was no significant difference between age and sex in terms of treatment success ($p$ = 0.175 and $p$ = 0.456, respectively). Treatment success rates for DV and GI were similar ($p$ = 1.00). In DV, the complete response rate was 67.4%, with a partial response rate of 20.9% and a nonresponse rate of 11.6%. In patients with GI, there was a complete response rate of 70.6%, a partial response rate of 17.6%, and a non-response rate of 11.8%, as shown in Figure 2.

In the analysis using the non-responsive group as a reference, no statistically significant effects of age, sex, or diagnostic group on treatment response were identified. However, the age variable demonstrated a positive correlation in both response categories: partial response and complete response. Notably, in the complete response group, the effect of age approached statistical significance ($p$ = 0.085, OR = 1.475, 95% CI: 0.947-2.296). The effects of sex and diagnostic group were not found to be significant, as shown in Table 2.

When treatment response was categorized as binary ("complete response" versus "partial/no response"), the analysis revealed that age, sex, and diagnostic group did not significantly influence the likelihood of achieving a complete response. The OR for age (OR = 1.118, 95% CI: 0.978-1.277, $p$ = 0.108) indicates that age is not a statistically significant factor, nor are the effects of the other variables considered, as shown in Table 3.

The average follow-up duration was 6.25 ± 2.97 months following the completion of BF therapy. The follow-up period was comparable between patients with DV and GI ($p$ = 0.28).

## DISCUSSION

In the present study we evaluated the results of BF therapy in children with DV and GI. Our results showed high complete response rates and no significant difference in treatment outcome between the two diagnosis groups. No significant association was found between treatment response and age or sex. These results indicate that BF therapy may be a valuable treatment option for children with both conditions, especially when standard urotherapy treatment is not sufficient enough.

Biofeedback therapy is commonly used in pediatric urology practice to address various voiding disorders.[6] Studies indicate that animated BF is more effective than non-animated BF.[7,8] Furthermore, the current literature demonstrates

**TABLE 2**
Results of multinomial logistic regression analysis

| | | Multinomial logistic regression analysis | | | |
|---|---|---|---|---|---|
| Independent variable | Treatment response | OR | Lower | Upper | $p$ |
| Diagnosis | Partial response | 0.881 | 0.098 | 7.925 | 0.910 |
| | Complete response | 0.781 | 0.118 | 5.153 | 0.798 |
| Age | Partial response | 1.331 | 0.831 | 2.132 | 0.233 |
| | Complete response | 1.475 | 0.947 | 2.296 | 0.085 |
| Sex | Partial response | 0.214 | 0.022 | 2.030 | 0.179 |
| | Complete response | 0.442 | 0.072 | 2.701 | 0.377 |

OR, odds ratio. The reference category for the dependent variable is "non-response". Results are considered statistically significant at $p < 0.05$.

**TABLE 3**
Binary logistic regression analysis predicting treatment response

| Predictor variable | OR | 95% CI for OR (Lower-Upper) | *p* |
|---|---|---|---|
| Diagnosis | 0.858 | 0.241-3.062 | 0.814 |
| Age | 1.118 | 0.978-1.277 | 0.108 |
| Sex | 1.148 | 0.645-2.043 | 0.641 |

OR, odds ratio; CI, confidence interval. The dependent variable is binary (0= partial/no response, 1= complete response). Results are considered statistically significant at $p < 0.05$.

that using BF-assisted pelvic floor muscle training as a physiotherapeutic method enhances the effectiveness of BF, especially when paired with game-based core exercises.[9,10] However, consensus on the optimal number and frequency of therapy sessions remains unattainable.[11]

The first step in treating DV typically involves urotherapy and addressing any accompanying constipation. Following this initial approach, BF therapy becomes a key component of the treatment process.[12] The goal of BF therapy is to instruct the patient on how to relax the sphincter and pelvic floor muscles during urination, which helps to normalize urinary function.

It has been reported that methylphenidate, anticholinergics, and BF can be utilized after standard urotherapy for the treatment of GI.[13] The primary objective of BF in GI patients, much like its application in DV, is to enhance awareness of the sphincter and pelvic floor muscles. However, given that complete relaxation of the pelvic floor muscles during laughter contributes to the condition's pathophysiology, the main focus of treatment is to strengthen the tone of the pelvic floor muscles outside of urination.

The ICCS advocates for BF in both scenarios.[5] Nonetheless, the success rates documented in the literature exhibit significant variability. Alyami et al.[14] reported a 65% success rate for BF therapy of DV and a patient satisfaction rate of 77%. Likewise, an additional study indicated a success rate of 75%.[15] Conversely, Reddy et al.[16] documented a success rate of 49% in patients with DV. In a recent study, the overall success rate for DV treatment was determined to be 65.6%, while the partial success rate was 21.9%.[17]

The effectiveness of BF application in treating GI has been reported in various studies with differing success rates. For instance, Richardson and Palmer[18] found a 60% rate of complete recovery, while Hacıislamoğlu et al.[13] reported that this rate increased to 94.1% after long-term treatment and follow-up. In another study, which involved a smaller patient cohort, the complete recovery rate with BF in GI treatment was determined to be 80%.[19]

The current study revealed that the success rates of BF application in both DV and GI treatments were significantly high. When including patients with partial responses, it is clear that the overall clinical benefit rates align with the literature and are at an impressive level. Additionally, while the pelvic floor muscle rehabilitation sought through BF varies between DV and GI patients, no difference in success rates was observed between the two groups.

The success of BF therapy can be influenced by various factors. Existing literature indicates that age does not significantly impact treatment success in patients with DV. However, a more recent study found that BF success was higher in patients aged nine and older compared to those who are younger. Notably, this study reported an overall success rate of 49% for BF therapy, which is relatively low compared to previous findings. Additionally, it is noteworthy that the success rate of BF in patients under nine years old was recorded as 0%.[16] Several studies have also indicated that sex does not significantly influence the efficacy of BF therapy.[15,20] Nonetheless, considering that the predominant demographic of patients necessitating BF is female, the conclusion that sex is inconsequential should be regarded with circumspection.

This study has several limitations that should be acknowledged. First, its retrospective design and relatively small sample size may limit the generalizability of the findings. Second, the limited number of nonresponders and the imbalance in the data may have reduced the ability to identify factors associated with treatment response. Although age showed a trend toward a positive association with treatment outcomes, this association did not reach statistical significance. Neither sex nor diagnostic group was significantly associated with treatment

response; however, these findings should be interpreted with caution given the limited sample size. Third, the study population was heterogeneous, as some children with DV had concomitant overactive bladder, and DV and GI have different underlying pathophysiological mechanisms. Finally, treatment success, particularly in children with GI, was assessed retrospectively and may have been subject to some degree of subjectivity. Larger, prospective studies with more balanced patient groups are needed to confirm these findings and further investigate potential factors influencing treatment response.

In conclusion, BF therapy yielded similar treatment outcomes in children with DV and GI. Most patients achieved a complete response, while a further proportion showed partial improvement. Age, sex, and diagnosis were not significantly associated with treatment outcomes, although the relatively small sample size may have limited the ability to detect such associations. Despite the retrospective design and the differences in the underlying mechanisms of these conditions, our findings suggest that BF may be considered a treatment option for children with either diagnosis who do not respond adequately to standard urotherapy. Prospective studies are needed to confirm these findings and identify factors that may influence treatment response.

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