J Ped Nephrol
Journal of Pediatric Nephrology
2025. Volume 13

Research Paper

Comparing the Prevalence of Muscle Weakness and Hypotonia Between Children With and Without Vesicoureteral Reflux

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Citation Haj Mohammad Hoseini Z, Shariatmadari F, Yousefichaijan P, Rafiei F, Malik A, Khodkar MA. Comparing the Prevalence of Muscle Weakness and Hypotonia Between Children With and Without Vesicoureteral Reflux. Journal of Pediatric Nephrology. 2025; 13:E50758. https://doi.org/10.22037/jpn.v13i1.50758

https://doi.org/10.22037/jpn.v13i1.50758

Article info:
Received: 12 Jan 2025
Accepted: 01 Mar 2025
Publish: 20 Jun 2025

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ABSTRACT

Background and Aim: Vesicoureteral reflux (VUR) is the abnormal return of urine from the bladder to the urethra and kidney. Muscle weakness means the decrease in muscle force. This study aimed to evaluate the presence of clinically detectable muscle weakness and hypotonia in children with VUR compared with children without reflux.

Methods: This research was a case-control study conducted at Amirkabir Hospital in Arak City, Iran. A total of 117 children were enrolled and divided into two groups. The first group, children with VUR confirmed by voiding cystourethrogram (VCUG) (N=58) and the second group, children with normal VCUG findings (N=59) approved by urologists. The two groups were then examined by a neurologist for hypotonia and muscle weakness. The information obtained was recorded in the checklist.

Results: There was a significant difference in regards to the gender of the case and control groups; however, no significant difference was observed regarding their age, birth weight, birth order, and neonatal situation. None of the patients had a history of hypotonia or muscle weakness. Out of the patients who had reflux, 16(27.58%) had right side reflux, 13(22.41%) had left side reflux, and 29(50%) had double sided reflux.

Conclusion: No patient from either group had signs of hypotonia or muscle weakness.

Keywords: Vesicoureteral reflux (VUR), Muscle weakness, Hypotonia

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Introduction

Vesicoureteral reflux (VUR) is the abnormal return of urine to the ureter and possibly the kidney from the bladder [1]. VUR is one of the most common dysfunctions of the urinary system in children, and according to the evidence, it seems that VUR has a genetical base [2]. Studies have shown that 30% of siblings of children with VUR also had VUR [2]. The most common reason for VUR is the congenital abnormality of the ureterovesical junction. Reflux disease could lead to urinary tract infections (UTIs), which could then create scars on the calyces and cortex of the kidney, cause glomerulonephritis and nephropathy due to the increased retrograde flow in the urinary system [1]. Currently, the most common way of diagnosing VUR is with voiding cystourethrogram (VCUG) and sometimes radionuclide cystogram (NCG), which is used to divide reflux into 5 different grades. In children less than 6, the first paraclinical step taken after the first UTI is VCUG and NCG [2, 3]. Depending on the severity, prognosis can be different. Some cases won't lose their renal function even though they have kidney injury. Despite this, VUR may progress to end-stage renal disease in both children and adults [4].

Hypotonia or flaccidity is when the muscles are soft and flimsy and lacks resistance to passive movements. Hypotonia is due to damage of the proprioceptive nerves of the muscle, or cerebellar diseases. It is also observed during spinal or cerebral shock. Lack of movement for a significantly long time can also cause hypotonia. Tone of muscle affects the normal movement of children and their growth. Low tone of muscle can cause problems in movement against gravity, e.g. straightening the elbow or lifting the chest from the ground. The extent of a limb movement is increased when it is flaccid. If a limb is passively moved to a position and then let go, the patient cannot keep their limb in that position and the limb will fall [5].

Although advanced chronic kidney disease has been associated with neuromuscular complications, such as muscle weakness and hypotonia [6], the relevance of these mechanisms to children with VUR—many of whom have preserved renal function—remains unclear. While hypotonia and muscle weakness have been well described in patients with chronic uremia and advanced renal failure [7], there is limited evidence regarding their occurrence in children with isolated VUR or early renal involvement. Given that VUR represents a spectrum of disease severity, it is important to determine whether neuromuscular manifestations can be detected in this population independent of overt chronic kidney disease. Therefore this study aimed to evaluate the presence of clinically detectable muscle weakness and hypotonia in children with VUR compared with children without VUR.

Materials and Methods

Study design and participants

This was a case-control study conducted at Amirkabir Hospital, Arak City, Iran, between 2017 and 2018. The source population consisted of children referred to the pediatric nephrology and urology clinics for evaluating urinary tract abnormalities, most commonly recurrent urinary tract infection, prenatal hydronephrosis, or abnormal renal ultrasonography findings. A total of 117 children were enrolled. The case group included 58 children diagnosed with VUR, confirmed by VCUG and interpreted by a pediatric urologist. The control group included 59 children who underwent VCUG for the same clinical indications but were found to have normal VCUG findings.

Children in the control group were selected from the same referral population as the cases to minimize selection bias. Controls had no evidence of VUR on imaging and no known history of neuromuscular or musculoskeletal disease. Written informed consent was obtained from parents or legal guardians prior to participation. Inclusion criteria were children who underwent VCUG and had either normal findings or confirmed VUR. Exclusion criteria were history of neuromuscular or musculoskeletal disorders, use of medications known to affect muscle tone or strength, and lack of parental consent.

Neurological assessment

All participants underwent a standardized clinical neurological examination performed by a pediatric neurologist. Muscle strength was assessed using the medical research council (MRC) grading scale, which grades muscle power from 0 (no contraction) to 5 (normal strength). Muscle tone was evaluated by assessing resistance to passive movement of the limbs. For infants and younger children unable to cooperate with formal strength testing, age-appropriate neurological examination techniques were used, including observation of spontaneous movement, posture, and resistance to passive motion, consistent with standard pediatric neurological examination practices.

The primary outcome was the presence or absence of clinically detectable muscle weakness or hypotonia on neurological examination.

Statistical analysis

Data were analyzed using SPSS software, version 23. Normality of continuous variables was assessed using the Kolmogorov-Smirnov test. Continuous variables were compared between groups using the Mann-Whitney U test due to non-normal distribution. Categorical variables were compared using the chi-square test or Fisher exact test, as appropriate. Results are presented as Mean±SD for continuous variables and number (percentage) for categorical variables. A $P<0.05$ was considered statistically significant.

Results

A total of 117 children were included in the study, comprising 58 children with VUR and 59 children with normal VCUG findings. No participant in either the VUR group or the control group demonstrated clinically detectable hypotonia or muscle weakness on neurological examination. None of the subjects had a history of neuromuscular disease. There were no statistically significant differences between the two groups with respect to age, birth weight, birth order, or neonatal condition. A statistically significant difference in sex distribution was observed between the groups (Table 1). Among children with VUR, 16 patients (27.58%) had right-sided reflux, 13 patients (22.41%) had left-sided reflux, and 29 patients (50%) had bilateral reflux (Table 2).

Discussion

In this case-control pilot study, no clinically detectable muscle weakness or hypotonia was identified in children with VUR or in controls. This finding suggests that overt neuromuscular abnormalities are unlikely in children with VUR who lack advanced renal impairment.

One possible explanation for the absence of neuromuscular findings is the relatively mild disease profile of the study population. Uremic myopathy and muscle weakness are typically observed in patients with advanced chronic kidney disease and markedly reduced glomerular filtration rates, whereas most children with VUR do not progress to such stages. In addition, children may demonstrate substantial neuromuscular compensation, further reducing the likelihood of clinically apparent weakness in early or uncomplicated disease. Another explanation relates to the method of assessment. This study focused on clinically detectable muscle weakness and hypotonia identified through neurological examination. While appropriate for screening purposes, this approach

Table 1. Baseline demographic and perinatal characteristics of children with and without VUR

Variables		Mean±SD/No. (%)		P
		VUR Group (n=58)	Control Group (n=59)	
Age (m)		46.98±35.37	48.79±45.34	0.801
Sex	Male	46(79.3)	35(59.3)	0.019
	Female	12(20.7)	24(40.7)	
Birth weight (g)		3115.5±404.4	3070±618.9	0.776
Birth order		1.67±0.6	1.67±0.68	0.906
Neonatal status, term		49(84.5)	50(84.7)	0.480

Note: P were calculated using the Mann-Whitney U test or chi-square test, as appropriate.

Table 2. Distribution of vesicoureteral reflux laterality among children with VUR

VCUG Findings	No. (%)
Right sided reflux	16(27.58)
Left sided reflux	13(22.41)
Bilateral reflux	29(50)

may not detect subclinical or functional muscle abnormalities that could be identified using objective tools such as handgrip dynamometry, electromyography, or muscle imaging.

Some previous studies have reported associations between VUR and musculoskeletal findings, such as joint hypermobility or musculoskeletal pain. However, these conditions represent distinct clinical entities and do not necessarily imply reduced muscle strength or abnormal muscle tone. Therefore, such findings are not inconsistent with the absence of clinically detectable hypotonia or muscle weakness observed in the present study.

This study has several limitations that should be considered when interpreting the findings. First, the sample size was relatively small, and no participant in either group demonstrated the primary outcome, which limits the statistical power to detect rare neuromuscular abnormalities. Consequently, the absence of observed muscle weakness does not exclude the possibility of subtle or infrequent associations. Second, renal function was not stratified according to chronic kidney disease stage, and biochemical markers of renal impairment were not incorporated into the analysis. This problem limits the ability to assess neuromuscular outcomes across different levels of renal dysfunction. Third, muscle strength and tone were assessed solely through clinical examination without the use of objective quantitative measures, potentially reducing sensitivity.

Additionally, a significant difference in sex distribution between the case and control groups may have introduced residual confounding. Finally, as a single-center study, the generalizability of these findings to other populations may be limited. Given the absence of observed neuromuscular abnormalities in both groups, this study was likely underpowered to detect small or rare effects. Therefore, the findings should be interpreted as preliminary and hypothesis-generating rather than definitive.

Despite these limitations, this study contributes preliminary clinical data suggesting that routine neurological screening for overt muscle weakness or hypotonia may not be necessary in children with VUR without advanced renal disease. Future multicenter studies with larger sample sizes, objective neuromuscular assessments, and inclusion of patients with varying degrees of renal impairment are needed to further clarify this relationship.

Conclusion

The results of this study showed that none of the children studied had hypotonia or a history of neuromuscular disease.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Research Ethics Committee of Arak University of Medical Sciences, Arak, Iran.

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

Authors' contributions

The authors equally participated to the study's conceptualization, methodology, data gathering, analysis, interpretation of findings, and writing of the manuscript. All authors have endorsed the final version for publication.

Conflict of interest

The authors declared no conflict of interest.

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