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Diagnostic Value of Echocardiography Parameters for Assessing Intravascular Status in Nephrotic Syndrome in Children

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ABSTRACT
The study included 80 children with different variants of nephrotic syndrome aged from 2 to 18 years. The state of intravascular volume was assessed by determining the index of the inferior vena cava, the index of contractility of the inferior vena cava, the diameter of the left atrium and the diameter of the aortic ring. In 28 patients, the average index of contractility of the inferior vena cava (%) was 11.94±7.80; the average diameter of the left atrium (mm / m2) was 22.09±12.42; the diameter of the aortic ring (mm) showed 25.34±5.64 results. In the remaining 52 patients, the average index of contractility of the inferior vena cava (%) was 13.98±5.21; the average diameter of the left atrium (mm/ m2) was 27.78±6.99; the diameter of the aortic ring (mm) showed 20.23±3.72 results. Echocardiographic parameters, such as the index of contractility of the inferior vena cava, the diameter of the left atrium and the diameter of the aortic ring, are the best predictor of the state of fluid volume in the body in NS and are a useful guide for assessing the state of intravascular volume in children. This study also showed that a wide range of patients with nephrotic syndrome are normovolemic or hypervolemic.
Key words: *Echocardiography, intravascular status, children, nephrotic syndrome.*

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INTRODUCTION

Nephrotic syndrome (NS) is a common kidney disease in childhood. The disease is characterized by massive proteinuria, hypoalbuminemia, and edema. Edema is one of the main characteristics of NS, but its pathogenesis is still not fully understood (1,2). Children with nephrotic edema have a general excess of both sodium and water. Edema in NS is generally thought to be caused by massive proteinuria, which leads to hypoalbuminemia and sodium and water retention to compensate for intravascular volume depletion (1–3). Although patients with NS have increased body water and sodium levels, the status of intravascular volume in these patients is somewhat controversial. Two hypotheses have been proposed to explain the intravascular conditions in NS: the underfill theory and the overfill theory (2–5). Assessment of intravascular volume in patients is usually demonstrated by clinical and biochemical findings. However, these data alone are not enough to estimate blood volume. In addition, vasoactive hormones, renal function tests, and lithium clearance can be used to assess intravascular volume. Other likely mechanisms of edema in NS are increased vascular permeability and primary increase in sodium retention in the kidneys due to increased levels of vasopressin, impaired response to atrial natriuritic peptide in NS, which can be caused by overactive efferent sympathetic nervous activity, excess Na + K + activity ATPase and renal epithelial sodium channel in the cortical collecting duct. Diuretics are well tolerated by patients with renal sodium retention, but if underfilling is the underlying mechanism, this may lead to worsening hypovolemia, as clinically evidenced by an increase in serum creatinine. Treatment includes general measures such as fluid restriction, emergency albumin transfusion, and diuretics that provide symptomatic relief before the steroids take effect. These measures require an assessment of body fluid volume to avoid circulatory disorders. Clinical parameters are not precise and CVP determination is invasive. Biochemical parameters are very expensive and not always available. Echocardiography and ultrasound used the inferior vena cava index (IVCI) and inferior vena cava collaboration index (IVCCI), which are used in adult patients because

these methods are non-invasive and help to determine intravascular volume load. Echocardiography and ultrasound, which is a non-invasive, cheaper and more readily available method, can quickly assess body fluid volume and help treat cases of nephrotic syndrome. Very few studies have been done to test IVCI, IVCCI, left atrial diameter (LAD), aortic annulus diameter (AD) for body fluid volume in children.

MATERIAL AND METHODS

The study was conducted by the National Children's Medical Center. The study included 80 patients aged 2 to 18 years who were in inpatient treatment with NS. There were 50 boys and 30 girls. NS was diagnosed on the basis of massive edema, high levels of proteinuria (> 40 mg/m2/h or urinary protein/creatinine ratio > 2.0 mg/mg) and hypoalbuminemia (<2. 5 g/dl). Echocardiographic studies to assess volumetric loading were performed by a pediatric cardiologist. The diameter of the inferior vena cava (IVC) during expiration and maximum inspiration was measured 1-2 cm below the diaphragm using color Doppler echocardiography. The IVC colloboration index (IVCCI) was tested using the following formula: [(maximum expiratory IVC diameter - minimum inspiratory diameter) / (maximum expiratory diameter)] × 100. Left atrial diameter (LAD) in the parasternal position was measured. LAD was defined as left atrial diameter (mm)/body surface area (m2). Aortic annulus diameter (AD) was examined independently of the 2D parasternal long axis view.

RESULTS AND DISCUSSIONS

Patients were divided into two groups as hypovolemic and non-hypovolemic according to their clinical manifestations. Tachycardia, dizziness, orthostatic collapse, muscle spasms, and decreased capillary refill time have been considered as clinical features of hypovolemia. Heart rate was higher, however systolic and diastolic blood pressure was lower in children with hypovolemia than in those without hypovolemia (Tables 1 and 2).

Table 1:Echocardiographic indicators of patients with hypovolemia

n=28	indicators
IVCCI (%)	11,94 ± 7,80;
Average LAD (мм/м2)	22,09 ± 12,42
AD (мм)	25,34 ± 5,64

Table 2: Echocardiographic parameters of patients with normovolemia

n=52	indcators
IVCCI (%)	13,98 ± 5,21
Average LAD (мм/м2)	27,78 ± 6,99
AD (мм)	20,23 ± 3,72

The balance between capillary hydrostatic pressure and capillary oncotic pressure prevents the formation of edema in healthy people. The state of intravascular volume in patients with NS is somewhat controversial. Two hypotheses have been proposed to explain the intravascular state in NS: the underfilling and overfilling hypotheses (6–7). The underfill hypothesis refers to a reduced effective circulating volume, while the overfill hypothesis refers to an expanded intravascular volume.

Echocardiographic parameters, including IVCCI, LAD, and AD, are a good indicator of circulating blood volume, and IVCCI is an accurate measure of right atrial pressure. These methods are reliable and relatively easy to use compared to other invasive methods. However, these methods can be difficult to use in pediatric patients, increasing the likelihood of obtaining inaccurate measurements, especially for patients with heart failure and/or heart disease. Significant differences can be observed depending on the individual performing the technique, making it difficult to obtain any useful information about the severity of volume overload. A study by Ozdemir et al in children with NS showed that between NS patients (0.66±0.33) and controls (0.60±0.3) for IVCI (P>0.05) (8 -9). The values for IVCCI in patients with nephrotic disease (39.4±8.6) were much lower than those calculated for controls (56.9±8.7). These results are similar to the present study. The mean values of IVC and IVCC in the present study in patients with nephrotic diseases (0.88±0.20, 35.61±13.68) and in the control group were (0.93±0.19, 52.23±2 .01). The p value was significant for the IVCC index. Donmez et al. studied inferior vena cava indices to determine volume load in children with minimal nephrotic syndrome. Twelve children with minimal HC change (7 boys, 5 girls) and 21 healthy controls were included in this study. Patients were divided into three different stages (stage A: edema; stage B: 50% reduction in weight gain; stage C: no edema) after measuring their ideal weight. IVCI

values were 6.1±0.6, 5.6±0.5, 5.9±0.4 and 6.09±0.3 in stages A, B, C and control group, respectively. IVCCI values were 57.3±2.6, 58.9±2.5, 62.9±2.6 and 65.0±1.6 in stage A, B, C and control group. There was no significant difference between edematous nephrotic stage A patients and controls in the IVCI, while there was a significant difference in the IVCCI. Although in the present study we did not group edematous patients according to weight loss, we only grouped edematous nephrotic patients in relapsed children and children of normal age and gender and found similar results. In a study by Nalcacioglu et al. To assess body fluid volume in children with nephrotic syndrome using bioelectrical impedance analysis, NTPro BNP and IVCI (10). In 38 patients with nephrotic syndrome before treatment (group 1) and in remission (group 2) and 42 healthy age and sex controls (group 3), IVCI values were 6.6±2.82, 6.2±2.54, 5.2±1.30 respectively in the group. 1, 2, 3, which did not differ significantly from each other. They did not calculate the IVCCI index, but the IVCI values were the same in all groups, as in the present study. For assessment of circulating blood volume, IVCCI and LAD have been described as valuable prognostic factors. A decrease in IVCCI and/or an increase in LAD indicate an elevated volemic status in patients.

CONCLUSION

Based on the results of our study, it can be concluded that echocardiographic parameters such as IVCCI, LAD, and AD are the best predictor of body fluid status in NS and are a useful guide for assessing intravascular volume status in children. This study also showed that a wide range of NS patients are normovolemic or hypervolemic. Although the mechanism of edema formation in patients may be multiple, the present study supports the overflow hypothesis, as evidenced by a significant increase in sodium concentration in nephrotic patients and IVCC <50% in most edematous patients.

REFERENCES

1. Doucet A, Favre G, Deschenes G. (2007). Molecular mechanism of edema formation in nephrotic syndrome: therapeutic implications. Pediatr Nephrol; 22(12):1983-90. doi: 10.1007/s00467-007-0521-3. Epub 2007 Jun 7.
2. Siddal EC, Radhakrishnan J. (2012).The pathophysiology of edema formation in the nephrotic syndrome. Kidney Int. ;82(6):635-42.doi: 10.1038/ki.2012.180. Epub 2012 Jun 20.
3. Schrier RW, Fassett RG. (1998). A critique of the overall hypothesis of sodium and water retention in the nephrotic syndrome. Kidney Int 53(5):1111-7.doi: 10.1046/j.1523-1755.1998.00864.x.
4. Dorhout Mees EJ, Geers AB, Koomans HA. (1984). Blood volume and sodium retention in the nephrotic syndrome: a controversial pathophysiological concept. Nephron;36(4):201-11. doi: 10.1159/000183155.
5. Ichikawa I, Rennke HG, Hoyer JR, Badr KF, Schor N, Troy JL, Lechene CP, Brenner BM. (1983). Role for intrarenal mechanisms in the impaired salt excretion of experimental nephrotic syndrome. J Clin Invest ;71(1):91-103. doi: 10.1172/jci110756.
6. Jaeger JQ, Mehta RL. (1999). Assessment of dry weight in hemodialysis: an overview. J Am Soc Nephrol. 999 10(2):392-403.doi: 10.1681/ASN.V102392.
7. Kaptein MJ, Kaptein EM. (2017). Focused real-time ultrasonography for nephrologists. Int J Nephrol. 3756857.doi: 10.1155/2017/3756857. Epub 2017 Feb2
8. Blehar DJ, Resop D, Chin B, Dayno M, Gaspari R. (2012). Inferior vena cava displacement during respirophasic ultrasound imaging. Crit Ultrasound J. 6;4(1):18. doi: 10.1186/2036-7902-4-18.
9. Ozdemir K, Mir MS, Dincel N, Bozabali S, Bulut IK, Yilmaz E et al. (2015). Bioimpedance for assessing volume status in children with nephrotic syndrome. Turk J Med Sci. 45:339-44. (In Russ.)
10. Nalcacioglu H, Ozkaya O, Baysal K, Kafali HC, Avci B, Tekcan D, et al. (2018). The role of bioelectrical impedance analysis, NT-ProBNP and inferior vena cava sonography in the assessment of body fluid volume in children with nephrotic syndrome. Nefrologia. 38(1):48-56.doi: 10.1016/j.nefro. 2017.04.003.

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