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Evaluation of Demographic, Clinical and Laboratory Parameters and Long-Term Renal Effects in Infants with Hypernatremic Dehydration

Hipernatremik Dehidratasyon Tanılı Bebeklerde Demografik, Klinik ve Laboratuvar Parametrelerinin Değerlendirilmesi ve Uzun Dönem Renal Etkiler

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Abstract

Aim: Neonatal hypernatremic dehydration is a potentially life-threatening condition in infants, primarily caused by inadequate breast milk intake. This study aimed to evaluate the demographic characteristics, clinical and laboratory findings, and risk factors in term neonates diagnosed with neonatal hypernatremic dehydration, as well as to assess its long-term impact on renal function.

Material and Method: This retrospective study included 36 term neonates diagnosed with Neonatal hypernatremic dehydration and followed in our clinic between January 2014 and December 2019. Data on demographics, clinical presentation, dehydration severity, laboratory values at admission, and serum creatinine and urea levels at follow-up (1–5 years later) were recorded. Dehydration was classified based on percentage of weight loss. Statistical analyses included Spearman correlation and ROC analysis to evaluate the relationship between hypernatremia and renal function.

Results: Of the 36 patients, 52.7% were male and 72.2% were delivered vaginally. Feeding difficulties (58%) and jaundice were the most common presenting complaints. Sixteen infants had >10% weight loss and were classified as moderately or severely dehydrated. Serum creatinine levels at admission were ≥0.6 mg/dL in 83% and ≥1.0 mg/dL in 28% of cases, suggesting significant renal involvement. At follow-up, creatinine levels normalized in all patients. The lack of urine output data was a limitation.

Conclusion: Neonatal hypernatremic dehydration is a serious but preventable condition. Risk is higher in infants born to primiparous mothers or by cesarean section. Early breastfeeding support, maternal education, and post-discharge follow-up are critical for prevention and early detection of potential renal complications.

Keywords: Dehydration, breastfeeding difficulties, kidney injury

Öz

Amaç: Yenidoğan hipernatremik dehidratasyonu, genellikle yetersiz anne sütü alımına bağlı olarak ortaya çıkan ve bebeklerde yaşamı tehdit edebilen bir klinik tablodur. Bu çalışmanın amacı, yenidoğan hipernatremik dehidratasyonu tanısı alan term yenidoğanların demografik özelliklerini, klinik ve laboratuar bulgularını ve risk faktörlerini değerlendirmek ve hastalığın böbrek fonksiyonları üzerindeki uzun dönem etkilerini incelemektir.

Gereç ve Yöntem: Bu retrospektif çalışmada, Ocak 2014 ile Aralık 2019 tarihleri arasında kliniğimizde hipernatremik dehidratasyon tanısı almış 36 term hasta değerlendirildi. Hastaların demografik verileri, klinik başvuru bulguları, dehidratasyon şiddeti, başvuru anındaki laboratuar değerleri ile 1–5 yaşlarında yapılan takiplerde ölçülen serum kreatinin ve üre düzeyleri kaydedildi. Dehidratasyon, kilo kaybı yüzdesine göre sınıflandırıldı. Hipernatreminin böbrek fonksiyonlarıyla ilişkisini değerlendirmek için Spearman korelasyon ve ROC analizleri kullanıldı.

Bulgular: Hastaların %52,7'si erkekti. 26 hasta (%72,2) vajinal yolla doğmuştu. En sık başvuru şikâyetleri beslenme güçlüğü (%58) ve sarılık olarak belirlendi. On altı bebekte %10'dan fazla kilo kaybı tespit edildi ve bu bebekler orta/ağır dehidrate olarak sınıflandırıldı. Başvuru anında serum kreatinin düzeyleri 30 hastada (%83) ≥0.6 mg/dL ve 10 hastada (%28) ≥1.0 mg/dL olup anlamlı böbrek tutulumu düşündürdü. Takiplerde tüm hastalarda kreatinin düzeyleri yaşa uygun normal aralıklara döndü. İdrar çıkışı verilerinin eksikliği çalışmanın bir sınırlılığıdır.

Sonuç: Yenidoğan hipernatremik dehidratasyonu ciddi bir durumdur. Risk, özellikle primipar, sezeryan ile doğum yapan annelerin çocuklarında daha yüksektir. Erken emzirme desteği, annelere yönelik eğitim ve taburculuk sonrası yakın takip, hem bu tablonun önlenmesi hem de olası böbrek komplikasyonlarının erken tanısı ve uygun müdahale yapılması açısından kritik öneme sahiptir

Anahtar Kelimeler: Dehidratasyon, emzirme güçlükleri, renal hasar

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INTRODUCTION

In recent years, it has become increasingly common for term newborns to be discharged within 24 hours after spontaneous vaginal delivery and within 72 hours after cesarean section. Although early discharge offers benefits such as enhanced maternal-infant bonding and reduced hospital-related costs and infection risks, it also presents certain clinical challenges. Notably, early discharge may hinder the timely identification and management of feeding difficulties, potentially leading toinadequate nutritional intake during the critical early days of life. Consequently, there has been a noticeable increase in hospital readmissions for conditions such as hyperbilirubinemia and dehydration, particularly those associated with insufficient breastfeeding. These preventable complications emphasize the importance of structured discharge planning, early post-discharge follow-up, and effective breastfeeding support for new mothers.[1]

Neonatal hypernatremic dehydration (NHD) is a potentially life-threatening condition that endangers the brain and other vital organs in neonates. It is defined by a serum sodium level greater than 145 mEq/L.[2] It may develop due to reasons such as inadequate fluid intake, excessive insensible losses, diarrhea, vomiting, or inadequate breastfeeding. The most common cause of hypernatremic dehydration is generally considered to be insufficient breast milk intake.[3] In the early days of life, insufficient amounts of breast milk significantly contribute to the development of this condition. The main reasons for this include the lack of maternal knowledge and skills in breastfeeding, cesarean delivery, infrequent breastfeeding, mismatch between mother and baby during breastfeeding, low educational level of mothers, and mistakes in breastfeeding techniques. Additionally, although less common, nipple issues can also contribute to breastfeeding insufficiency.[4]

Hypernatremic dehydration is recognized as a significant contributor to neonatal morbidity and mortality. Among the various complications associated with this condition, renal dysfunction plays a particularly critical role. The kidneys, being highly sensitive to changes in fluid and electrolyte balance, are especially vulnerable during episodes of severe dehydration. Prerenal acute kidney injury, is frequently observed due to decreased renal perfusion, is frequently observed in affected neonates. If not promptly diagnosed and managed, such renal complications may lead to long-term impairment or even permanent renal damage.[5]

The aim of this study is to evaluate the demographic characteristics, associated complaints, and risk factors of infants diagnosed with hypernatremic dehydration; to stage the severity of dehydration and assess laboratory parameters. Additionally, the study aims to evaluate the long-term effects of hypernatremic dehydration on the renal function of these infants.

MATERIAL AND METHOD

The study was carried out with the permission of Selçuk University Ethics Committee (Date: 30.12.2020, Decision No: 2020/576). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Retrospective evaluation was performed on term neonates diagnosed with hypernatremic dehydration and followed in our clinic between January 2014 and December 2019. Among these patients, 36 who were readmitted to our hospital 1 to 5 years after the initial diagnosis and had renal function tests (urea/creatinine) were included in the study. The demographic characteristics, clinical and laboratory findings, follow-up data, observed complications, and urea and creatinine levels measured at the time of re-evaluation were recorded.

Data collected included the date and reason for admission, type and week of birth, birth weight, body weight and percentage of weight loss at admission, serum sodium, blood urea nitrogen, creatinine, total and indirect bilirubin levels, dehydration status, and length of hospitalization. During follow-up evaluations, patient age, serum urea and creatinine levels were recorded. Patients who lost 7–10% of their body weight were classified as mildly dehydrated, those with 10–15% loss as moderately dehydrated and >15% as severely dehydrated.

Statistical analyses of the study were performed using IBM SPSS Statistics version 20. Continuous variables were assessed for normal distribution; variables with normal distribution were presented as mean±standard deviation, while those without normal distribution were expressed as median (minimum–maximum). Categorical variables were reported as counts and percentages. For comparisons between groups, the Independent Samples t-test or the Mann–Whitney U test was used depending on the distribution of the data, and the Chi-square test was applied for categorical variables.

To evaluate the relationship between the severity of neonatal hypernatremia and later renal function parameters, Spearman correlation analysis was performed. In addition, receiver operating characteristic (ROC) curve analysis was used to assess the predictive value of hypernatremia levels for renal squeal. A p-value of <0.05 was considered statistically significant.

RESULTS

Of the 36 patients included in the study, 19 were male (52,7%). The majority of the patients were delivered via spontaneous vaginal delivery (26/72,2%). The demographic and laboratory data of the patients are summarized in **Table 1**. When evaluating the patients based on their presenting complaints, feeding problems were identified as the most common reason for admission. Distribution of cases based on presenting complaints and degree of dehydration on physical examination is presented in **Table 2**. Patients were categorized into three groups—mild, moderate, and severe dehydration—based on their clinical status at admission. The admission and follow-up characteristics of these groups are summarized in

Table 3. As expected, weight loss at the time of admission, both in grams and as a percentage, was significantly higher in the severely dehydrated group (P=0.001). Similarly, serum sodium, urea, and creatinine levels at admission were also found to be significantly elevated in this group compared to the others (P=0.003 and P=0.001, respectively). However, when comparing follow-up values, no statistically significant differences were observed among the three groups in terms of urea and creatinine levels (P=0.477 and P=0.547, respectively).

Table 1. Demographic and laboratory characteristics of the patients.

Sex (Male/Female)	19/17
Mode of Delivery (Vaginal/Cesarean)	26/10
Parity (Primiparous/Multiparous)	20/16
Birth Weight (g)	3121.61±382.37 (2245-3820)
Gestational Age (weeks)	38.58±1.22 (37-41)
Age at Admission (days)	4.72±2.32 (2-13)
Weight at Admission (g)	2789.72±330.11 (2060-3400)
Weight Loss (g)	331.94±129.87 (185-760)
Weight Loss (%)	10.52±3.43 (6.54-21.11)
Maternal Age (years)	27.92±6.26 (18-43)
Serum Sodium (mEq/L)	151.88±7.03 (145-177)
Blood Urea Nitrogen (mg/dL)	52.58±42.02 (14.60-240.50)
Serum Creatinine (mg/dL)	0.88±0.39 (0.40-2.39)
Total Bilirubin (mg/dL)	14.27±4.91 (2.3-22.5)
Indirect (Unconjugated) Bilirubin (mg/dL)	13.72±4.91 (1.4-22)

Table 2. Distribution of Cases Based on Presenting Complaints and Degree of Dehydration on Physical Examination

Clinical Findings and Physical Examination Characteristics	n	%
Feeding Difficulty	22	61.1
Jaundice	22	61.1
Restlessness	6	16.7
Fever	4	11.1
Mildly dehydrated	20	55.5
Moderately dehydrated	10	27.7
Severely dehydrated	6	16.6

Table 3. Demographic characteristics of the patients according to the degree of dehydration

	Mild	Moderate	Severe	p
Postnatal age at admission	4.35±1.84	3.9±0.88	7.33±3.67	0.077
Age at follow-up	2.8±1.74	2.8±1.62	3.5±1.97	0.710
Birth weight	3070±392.01	3139±368.77	3265±398.53	0.660
Gestational age at birth	38.6±1.19	38.4±1.35	38.83±1.33	0.737
Admission weight	2820±355.82	2777.5±316.68	2709.17±299.04	0.901
Weight loss (g)	250±44.57	361.5±56.18	555.83±126.82	0.001
Weight loss (%)	8.13±0.82	11.48±0.69	16.92±2.28	0.001
Maternal age	27.1±5.74	27.5±6.79	31.33±7.03	0.357
Serum sodium (na)	149.25±4.25	150.9±3.14	162.33±9.97	0.003
Serum urea at admission	37.67±14.83	39.23±15.01	124.58±60.45	0.001
Follow-up urea	23.23±9.74	21.38±5.05	17.5±8.55	0.477
Serum creatinine at admission	0.79± 0.31	0.74±0.15	1.43±0.51	0.001
Follow-up creatinine	0.35± 0.09	0.35± 0.10	0.32± 0.07	0.547
Length of hospital stay	3.35±1.39	3±0.82	4.02± 0.92	0.680

DISCUSSION

Fluid and electrolyte balance is very important in the newborn period. In patients with inadequate nutritional support, hypernatremic dehydration may develop, potentially leading to significant morbidity and even mortality. This clinical condition can be associated with serious complications such as acute kidney failure, disseminated intravascular coagulation (DIC), seizures, and multiple cerebrovascular events.[6]

Clinical manifestations of hypernatremic dehydration typically emerge within the first 10 days of life.[1] In our study, the mean age at admission was 4.7 days. To ensure successful breastfeeding, breast milk should be initiated as early as possible after birth.[7] In deliveries by cesarean section, the initiation of feeding is often delayed, which may lead to an increased incidence of hypernatremic dehydration in newborns.[8] Primiparous mothers may face greater challenges with breastfeeding due to limited experience and inadequate education, which can increase the risk of feeding difficulties in newborns. These challenges can be mitigated through structured education and support focused on neonatal feeding practices.[9] In our study, 28% of the infants were delivered via cesarean section, and 56% of the mothers were primiparous. Regardless of the mode of delivery, early initiation of breastfeeding is essential to ensure adequate milk intake, and mothers should be adequately supported in the immediate postnatal period.

Manganaro et al. demonstrated that a weight loss of ≥10% within the first days of life serves as a simple and effective indicator for the early detection of dehydration prior to the development of severe hypernatremia.[10] In our study, weight loss was also used as a criterion for evaluating dehydration severity. Sixteen infants who experienced more than 10% weight loss were classified as moderately or severely dehydrated.

The most common presenting complaints in neonates with hypernatremic dehydration typically include poor feeding, decreased urine output, brick-red or orange-colored staining of the diaper due to urate crystals, jaundice, and elevated body temperature.[3] These clinical signs often reflect underlying fluid and electrolyte imbalances and may be overlooked in the early postnatal period, particularly in infants who are discharged early. In our study, the most frequently reported symptoms at admission were feeding difficulties and jaundice, observed in 58% of cases. These findings are consistent with the early manifestations of inadequate breastfeeding and developing dehydration. In addition, restlessness and fever were noted as accompanying complaints, which may indicate systemic distress and worsening dehydration status. Recognizing these early clinical signs is crucial for timely intervention, as delays in diagnosis and treatment can lead to severe complications, including renal dysfunction and neurological impairment.

The major complications of HDH are disseminated intravascular coagulation, vascular complications, intracranial hemorrhage, convulsion and brain damage.[11] Acute kidney injury (AKI) is among the complications observed in these patients. While the literature extensively reports the causes of acute morbidity and mortality associated with this condition, studies investigating the long-term neurodevelopmental and physical morbidities of hypernatremia remain limited.

Although neonatal hypernatremia can often be corrected with timely and appropriate fluid resuscitation, more severe or treatment-resistant cases may require renal replacement therapies such as peritoneal dialysis or hemodialysis.[12] In instances of severe hypernatremic dehydration, there is a significant reduction in intravascular volume, which compromises renal perfusion. This reduction in renal blood flow leads to prerenal acute kidney injury, which is the most commonly observed form of AKI in neonates. Prerenal AKI accounts for approximately 85% of all neonatal AKI cases and, if left unrecognized or inadequately managed, may progress to intrinsic renal injury.[13] Early identification and intervention are therefore critical to prevent irreversible renal damage and long-term sequelae.

Acute kidney injury is defined as a sudden decline in renal function, leading to impaired regulation of fluid, electrolyte, and acid-base homeostasis, ineffective blood pressure control, and accumulation of nitrogenous metabolic waste products.[14] While it is generally accepted that the diagnosis of renal failure should be based on the degree of increase in serum creatinine rather than an absolute threshold, in term neonates without identifiable risk factors, a creatinine level exceeding 0.6 mg/dL should prompt consideration of acute kidney injury.[15] In neonates who develop acute kidney injury, the prognosis is influenced by the underlying etiology, gestational age, and birth weight.[16] Furthermore, chronic renal impairment may develop in approximately 10% to 16% of survivors. Factors influencing the spectrum of acute kidney injury to acute kidney disease and to chronic kidney disease transition include the type of kidney injury, pre-existing chronic conditions, and genetic factors.[17] Among our cases, 83% (n=30) had serum creatinine levels above 0.6 mg/dL, while 28% (n=10) had levels exceeding 1.0 mg/dL. Elevated creatinine levels are important as they indicate the severity of renal involvement. One of the limitations of our study is the absence of data on urine output volumes. However, in the follow-up assessments, creatinine levels in all of our cases were within the age-appropriate normal range. This may be attributed to the high rate of renal regeneration and strong renal plasticity during the neonatal period.[18] There are significant functional changes that continue to take place as the infant matures. Nephrogenesis is complete by 34th–36th week of gestation; however, the maturation of the kidney continues through the postnatal period.[19] In addition, the careful implementation of treatment approaches aimed at maintaining fluid-electrolyte balance, regulating blood pressure, and preserving acid-base homeostasis in infants admitted to our clinic with hypernatremic dehydration was considered an important factor in the improvement of renal function and the prevention of progression to chronic kidney disease.

CONCLUSION

Hypernatremic dehydration resulting from breastfeeding difficulties is a serious and potentially life-threatening clinical condition in the neonatal period. However, it is largely preventable through early recognition and timely intervention. Infants with inadequate feeding history and those born to mothers who were not sufficiently informed about neonatal care and breastfeeding during pregnancy—particularly primiparous mothers—should be closely monitored throughout their hospital stay. These mothers should be provided with confidence-building, comprehensive, and practical education on breastfeeding and feeding techniques. Additionally, early post-discharge follow-up appointments should be scheduled, and families should be thoroughly informed about potential complications that may arise due to insufficient nutrition. It is also of great importance to continue follow-up after the completion of treatment in order to monitor for potential long-term complications in these infants.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Selçuk University Ethics Committee (Date: 30.12.2020, Decision No: 2020/576).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

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