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COMPARATIVE EFFICACY OF RICE – ORS AND GLUCOSE – ORS IN MODERATELY DEHYDRATED TURKISH CHILDREN WITH DIARRHEA*

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SUMMARY: Yurdakök K, Yalçın S. (Department of Social Pediatrics, Hacettepe University Institute of Child Health, Ankara, Turkey). Comparative efficacy of rice-ORS and glucose-ORS in moderately dehydrated Turkish children with diarrhea. Turk J Pediatr 1995; 37: 315-321.

The efficacy of precooked rice-based (50 g/L) oral rehydration solution (R-ORS) was compared with standard glucose-based ORS (G-ORS) in a randomized controlled trial in 79 children who were moderately dehydrated due to diarrhea. ORS intake rate and weight gain after rehydration were found to be similar in the two treatment groups ($p > 0.05$). The time necessary for rehydration was significantly lower in the R-ORS-treated group than in the G-ORS-treated group (5.2 ± 2.2 and 7.5 ± 3.4 hours, respectively, $p < 0.05$). Although the mean serum bicarbonate levels were significantly increased in both treatment groups at the end of the treatment, a significant increase in the mean pH value was observed in only the R-ORS treated group ($p < 0.05$). *Key words: diarrhea, treatment, rice-based oral rehydration solution.*

The WHO/UNICEF-recommended glucose-based ORS (G-ORS) has greatly reduced the case-fatality rate for acute diarrhea among children in developing countries. Despite its wide availability, global G-ORS usage is only about 23 percent in all diarrheal episodes[1]. One of the main reasons for its under-use is that G-ORS effectively replaces fluid loss but does not decrease stool volume and frequency, and may even increase it[2, 3]. This is of practical concern to both mothers and health workers and leads to increased, unnecessary use of antidiarrheal drugs[1].

Studies are focused on alternate solutions containing starch instead of glucose, mainly rice-based oral rehydration solutions (R-ORS), to increase the co-transport molecules for the coupled transport of sodium without increasing the osmolality[4]. Studies with rice-based solutions containing 30-50 g rice powder for each liter of water have been shown to reduce stool output and diarrhea duration[4]. In Turkey, G-ORS has been used for rehydration treatment since the early 1980s, but its usage is similar to the world average[5]. As far as we know, no clinical experience has been reported on the comparison of R-ORS and G-ORS treatment in Turkish children. Therefore, this study was conducted to evaluate the comparative efficacy of R-ORS and G-ORS on the treatment of diarrheal dehydration by assessing the frequency of watery stool, vomiting, duration of rehydration, amount of ORS consumed for rehydration and improvement in metabolic acidosis among Turkish children.

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Material and Methods

This study was carried out from September 1993 to September 1994 at the Hacettepe University İhsan Doğramacı Children's Hospital Diarrhea Training and Treatment Unit. After initial clinical history-taking, patients were examined to determine the degree of dehydration, nutrition and the presence of associated conditions. Children who were diagnosed as moderately dehydrated due to diarrhea according to standard clinical criteria[6] were enrolled in the study, and those with systemic infections or other diseases requiring specific additional treatments were excluded.

Patients were randomly assigned to two treatment groups. Children in one group were treated with a precooked R-ORS solution prepared by WHO, and the other group received the standard WHO/UNICEF-recommended G-ORS containing citrate as the base. The composition of rice-based ORS was identical to that of glucose-based ORS except that glucose was replaced by 50 g precooked, whole rice powder. Some of the characteristics of G-ORS and R-ORS are summarized in Table I.

Table I: Comparison of the Oral Solutions Used to Treat Infants with Diarrhea

	Rice-ORS	Glucose-ORS
Sodium (mmol/L)	90	90
Potassium (mmol/L)	20	20
Chloride (mmol/L)	80	80
Citrate (mmol/L)	10	10
Glucose (mmol/L)	–	111
Rice powder (g/L)	50	–
Osmolality (mOsm/L)	250	308

All patients were given 100 ml/kg of body weight of the assigned ORS solution during the first four hours of treatment, and then reassessed frequently for signs of dehydration. Patients were discharged when the signs of dehydration disappeared.

If signs were still present at the end of four hours, the calculated deficit was again replaced with the assigned ORS. This procedure was repeated until signs of dehydration disappeared. Treatment failure was defined as deterioration in clinical signs of dehydration after two hours of treatment, or failure to maintain fluid and electrolyte balance with oral fluids because of persistent vomiting or a high purging rate. All patients were weighed on admission and on completion of rehydration.

Blood samples were taken on admission and after complete rehydration for the measurement of serum sodium, potassium, chloride and bicarbonate concentrations as well as blood pH levels by standard methods. Frequency (no. per hr) of vomiting and stool output in the 24 hours before admission and during the treatment were also recorded.

The efficiency of treatment was assessed by the frequency of watery stool and vomiting, the duration of rehydration, the amount of ORS consumed for rehydration and the improvement in metabolic acidosis.

Statistical analyses were done with Epi-info Version 5 software. Chi-square and Student's t tests were used to compare the groups.

Results

On admission, there were no significant differences ($p > 0.05$) in the clinical characteristics between the treatment groups (Table II).

Table II: Characteristics of Patients on Admission

	Rice-ORS (n: 37)	Glucose-ORS (n: 42)
Male/Female	27/10	28/13
Age (months)	12.6 ± 9.3	10.6 ± 7.0
Body weight (kg)	8.2 ± 2.3	7.7 ± 2.2
Duration of diarrhea before admission (days)	7.8 ± 6.9	5.8 ± 4.6

Values denote means ± SD.
No statisticaly significant differences were found between the groups ($p > 0.05$).

Treatment was unsuccessful in five (14%) of 37 infants treated with R-ORS and nine (21%) of the 42 infants treated with G-ORS. Treatment failure was comparable in the two groups (Table III).

Table III: Clinical Outcome of the Patients

	Rice-ORS (n: 37)	Glucose-ORS (n: 42)	Total (n: 79)
Successfully treated (%)	32 (86)	33 (79)	65 (82)
Treatment failures (%)	5 (14)	9 (21)	14 (18)

Yates corrected Chi-Square 0.39, $p = 0.53$

On admission, the treatment groups had similar numbers of patients with vomiting. During rehydration, fewer patients had vomiting in the R-ORS treated group but the difference was not statistically significant ($p > 0.05$). The frequency of vomiting during rehydration remained the same when compared with admission levels within and also between the treatment groups ($p > 0.05$) (Table IV).

The mean frequency of stool output increased significantly during rehydration in both the R-ORS and G-ORS-treated patients (Table IV).

The ORS intake rate (ml/kg/hr) and weight gain after rehydration were similar in the two treatment groups ($p > 0.05$). However, infants treated with R-ORS required significantly less oral rehydration fluid for treatment ($p < 0.05$, Table IV).

Table IV: Clinical and Laboratory Features of Patients Before and During Rehydration Phase

	Rice-ORS (n: 37)	Glucose-ORS (n: 42)
No. of patients with vomiting (%)		
On admission	25 (66)	30 (71)
During rehydration	9 (24)	15 (36)
Frequency of vomiting (No. of vomiting per hour)		
On admission	0.21 ± 0.13	0.27 ± 0.17
During rehydration	0.23 ± 0.12	0.30 ± 0.28
Frequency of stool output (No. of stool per hour)		
On Admission	0.30 ± 0.16	0.34 ± 0.36
During rehydration	0.71 ± 0.42**	0.60 ± 0.31**
ORS intake rate (ml/kg/hr)	18 ± 6	20 ± 7
Net ORS requirement (ml/kg)	108 ± 29*	135 ± 42
Weight gain after rehydration (% of admission weight)	5.6 ± 2.9	6.2 ± 3.1
Duration of rehydration (hr)	5.8 ± 2.2*	7.5 ± 3.4
Blood pH		
On admission	7.30 ± 0.08	7.29 ± 0.06
After rehydration	7.36 ± 0.07***	7.31 ± 0.03
Serum HCO_3^- (mmol/L)		
On admission	14.4 ± 3.4	14.0 ± 2.9
After rehydration	16.1 ± 3.1**	16.2 ± 2.4**
Serum Na^+ (mmol/L)		
On admission	138 ± 5	140 ± 7
After rehydration	140 ± 5	142 ± 6
Serum K^+ (mmol/L)		
On admission	3.7 ± 0.6	4.3 ± 0.7
After rehydration	3.9 ± 0.7	4.0 ± 0.8

Results given as means ± SD

* Significant differences were found between the groups ($p < 0.05$).

** Significantly different from admission levels ($p < 0.05$).

The mean duration of rehydration, measured as the time between the initiation of oral rehydration therapy and the disappearance of signs of dehydration, was significantly lower ($p < 0.05$) in the R-ORS treated group (Table IV).

No significant difference was observed between the treatment groups in the mean serum concentrations of sodium and potassium at the time of admission and after rehydration (Table IV).

On admission, the mean blood pH and serum bicarbonate levels were similar ($p > 0.05$), and the mean blood pH levels revealed mild-moderate metabolic acidosis ($7.20 < pH < 7.35$) in both R-ORS and G-ORS-treated patients. At the end of treatment, the mean serum bicarbonate levels increased significantly in both treatment groups; however, a significant increase in the mean pH value was observed in only the R-ORS-treated group ($p < 0.05$). The mean blood pH level measured after rehydration was also higher in the R-ORS-treated group than in the G-ORS group ($p < 0.05$, Table IV).

Discussion

According to the results of a meta-analysis of 13 randomized clinical trials involving 1367 patients published in 1992, rice-based oral rehydration solutions (R-ORS) containing 50-80 g/L rice-powder decreases the stool volume and treats dehydration more effectively, especially in patients with cholera. However, the effect was found to be substantially less for non-cholera diarrhea in these studies[7]. Later studies were performed to compare the effect of treatment with R-ORS and G-ORS on total stool output and duration of diarrhea in children with acute non-cholera diarrhea and showed no difference between the two treatment groups[1,8]. In particular, G-ORS was found to be as efficacious as R-ORS when patients were given food immediately after the correction of dehydration[8].

There is still uncertainty, however, about the clinical advantage of R-ORS in the treatment of dehydrated children. We had an experience of a 10-month-old, severely dehydrated and severely acidotic (pH = 6.96) infant who improved and became moderately dehydrated with R-ORS treatment in four hours (pH = 7.22), but then deteriorated when treatment continued with G-ORS (pH = 7.11) and again improved and successfully rehydrated when R-ORS was given (pH = 7.30) for the following eight hours of treatment. As we know from previous experience, improvement of a moderate to severe degree of metabolic acidosis is slower and usually takes 11 hours of rehydration treatment with G-ORS[3]. Although the two solutions contained the same amount of base precursor, this study shows the superiority of R-ORS over G-ORS in terms of improving metabolic acidosis, an issue which is not clearly discussed in previous studies, and reducing the necessary time for rehydration.

Contrary to previous reports, we observed increased frequency of stool output during the rehydration period, not only in G-ORS-treated patients but also in the R-ORS-treated group[9,10]. An increase in the mean frequency of stool output during rehydration treatment with G-ORS has been reported before without affecting the treatment success[3,4]. This increase is explained with the relatively higher osmolality of G-ORS, which may cause osmotic diarrhea if given in excessive amounts[11,12].

In this study, despite increased frequency of stool output, successful rehydration and weight gain as well as greater improvement in metabolic acidosis was achieved in a shorter time with R-ORS, suggesting that the volume absorbed with R-ORS is better than that with G-ORS. Because hydrolysis of oligosaccharides by brush border enzymes occurs in close proximity to glucose transport sties, there is a greater local concentration of glucose for absorption than would occur with random diffusion of free glucose[11]. Therefore, the higher carbohydrate content of R-ORS increases the absorption of sodium and water without an osmotic penalty[4,11]. The R-ORS used in this study had a lower osmolality (250 mOsm/L) than does G-ORS (308 mOsm/L). In another study, hypotonic G-ORS (224 mOsm/L) containing 60 mmol/L sodium and 84 mmol/L glucose was shown to have clinical advantages over istonic (304 mOsm/L) G-ORS in terms of decreasing diarrheal stool, diarrheal duration and hospital stay; this finding suggested that the hypotonicity of the ORS solutions was more important than its glucose type for optimal water absorption[13]. The mean weight gain in hypotonic and isotonic G-ORS-treated groups was found to be less than had been assumed, and was explained by overestimation of initial dehydration. Although the number of diarrheal stools on admission was not recorded in that study, the frequency of stool output with isotonic G-ORS during treatment was similar (0.56 ± 0.50) to that observed in our study. Thus more ORS is needed to overcome increased fluid loss due to increased frequency rather than overestimation of dehydration.

In summary, our findings show that R-ORS shortens the rehydration period and corrects metabolic acidosis better than G-ORS. These clinical advantages are important for many Diarrhea Training and Treatment Units where overnight stays and/or 24 hour follow-up of patients are unavailable.

REFERENCES

1. World Health Organization. Programme for control of diarrhoeal diseases. Ninth Prgramme Report 1992-1993. WHO/CDD/94.46. WHO, Geneva, 1994.
2. Field M, Rao MC, Chang EB. Intestinal electrolyte transport and diarrheal disease. N Engl J Med 1989; 321: 879-883.
3. Yurdakök K, Oran O, Şeref B. İshale bağlı ağır metabolik asidozun ağızdan sıvı tedavisi ile düzeltilmesi. Çocuk Sağlığı ve Hastalıkları Dergisi 1992; 35: 109-114.
4. Lebenthal E. Rice as a carbohydrate substrate in oral rehydration solutions (ORS). J Pediatr Gastroenterol Nutr 1990; 11: 293-303.

5. Sağlık Bakanlığı (Türkiye), Hacettepe Üniversitesi Nüfus Etütleri Enstitüsü ve Macro International Inc. 1994 Türkiye Nüfus ve Sağlık Araştırması 1993, Ankara, Türkiye.
6. WHO. A manual for the treatment of acute diarrhoea for use by physicians and other senior health workers. WHO/CDD/SER 80.2 REV 1. WHO, Geneva, 1984.
7. Gore SM, Fontaine O, Pierce NF. Impact of rice-based oral rehydration solution on stool output and duration of diarrhoea: meta-analysis of 13 clinical trials. Br Med J 1992; 304: 287-91.
8. Fayad IM, Hashem M, Duggan C, et al. Comparative efficacy of rice-based and glucose-based oral rehydration salts plus early reintroduction of food. Lancet 1993; 342: 772-775.
9. Prasad B. Rice-based oral rehydration solution: a controlled trial in Nepal. J Trop Pediat 1993; 39: 368-369.
10. Kenya PR, Odongo HM, Oundo G, et al. Cereal based oral rehydration solutions. Arch Dis Child 1989; 64: 1032-1035.
11. Lebenthal E, Lu RB. Glucose polymers in diarrhea-high caloric density nutrients with low osmolality. J Pediatr Gastroenterol Nutr 1990; 11: 1-6.
12. Field M, Rao MC, Chang EB. Intestinal electrolyte transport and diarrheal disease. N Engl J Med 1989; 321: 879-883.
13. Rautanen T, El-Radhi S, Vesikari T. Clinical experience with a hypotonic oral rehydration solution in acute diarrhoea. Acta Paediatr 1993; 82: 52-54.