ORIGINAL ARTICLE

Rice Starch Low Sodium Oral Rehydration Solution (ORS) in Infantile Diarrhoea

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Summary

The relative efficacy and incidence of hypernatremia of a rice starch based low sodium (sodium of 60 mmol/L) oral electrolyte solution was compared to the standard WHO oral rehydration solution (ORS; sodium 90 mmol/L) in 60 infants with non choleragenic acute diarrhoea. Both solutions were found to be equally effective in correcting dehydration as determined by the respective post hydration weight gain which was 150 ± 175 gms in the rice starch low sodium ORS group and 164 ± 125 gms in the standard WHO ORS group. However, the mean frequency of stools was greater and the duration of stay longer in the WHO ORS group compared to the rice starch low sodium group. There were 5 cases of hypernatremia in the WHO ORS group as opposed to only one in the rice starch low sodium ORS group.

The present study shows that a rice starch low sodium ORS was as effective as the standard WHO ORS and had a lower incidence of hypernatremia in the fluid and electrolyte management of infants with non choleragenic diarrhoea.

Key Words: Acute gastroenteritis, Oral rehydration solution, Hypernatremia, Diarrhoea

Introduction

Oral rehydration with a glucose-polyelectrolyte solution forms an established method of correcting fluid and electrolyte imbalance in acute infantile diarrhoea[1,2]. Glucose mediated sodium absorption forms the basis of oral rehydration therapy. However, glucose contributes significantly to the osmolality of the solution but it is expensive and many children find it unpalatable. In 1976, we observed that rice starch based ORS with the electrolyte composition closely similar to that recommended by the World Health Organisation (WHO), was effective in correcting dehydration in infantile diarrhoea[3,4]. Since then several other independent studies have confirmed that rice starch ORS is highly effective in both choleragenic and non choleragenic diarrhoea[5,6]. On the basis of studies in choleragenic diarrhoea the current standard WHO ORS was formulated[2]. However, in young infants, the use of the standard WHO ORS which contains 90 mmol/L sodium is often associated with a higher incidence of hypernatremia when compared to a glucose based ORS with a lower sodium concentration of 60 mmol/L[4,7]. Although rice based ORS with 80-90 mmol/L sodium, has been shown to be more effective than the standard WHO ORS, there are no studies to date on the effectiveness of a rice based ORS with a lower sodium concentration. The present study was undertaken to compare a rice based electrolyte solution containing 60 mmol/L of sodium with the standard WHO ORS in relation to (i) their respective effectiveness to correcting dehydration, and (ii) the incidence of hypernatremia.

Patients and Methods

Sixty children aged 5 months to 2 years presenting with acute watery diarrhoea and signs of mild to moderate dehydration were studied. Informed consent was obtained from the parents before the infants were included in the study. A full clinical examination was performed and the weight and height measured at the time of admission. Each child was assigned randomly to either rice starch ORS or WHO ORS.

Rice starch ORS was prepared by overcooking 100 gm polished rice in 1 litre of water, and to the rice water was added appropriate amounts of water and electrolytes so that 1 litre of the solution contained 60 mmol/L of sodium, 20 mmol/L of potassium, 60 mmol/L of chloride and 20 mmol/L of bicarbonate. Microscopic examination of stools, clinitest for reducing sugars and microbiological culture of stool samples were performed. Blood samples were collected on admission and 24 hours after treatment for a complete blood count, and estimation of haemoglobulin and electrolytes. The clinical profile and stool findings are summarised in Table I. In this study hypernatremia was defined as a serum sodium level > 145 mmol/L.

Table I
Clinical features of 60 infants with acute gastroenteritis at admission

Clinical Parameters	Rice ORS	WHO ORS
No. of patients	30	30
Age (months)		
Mean	11.3 ± 5	12.1 ± 6.4
Range	(5 – 24)	(5 – 24)
Duration of diarrhoea (days)	2.9 ± 2.5	3.6 ± 2.9
Stool frequency	6.2 ± 2	6.2 ± 3.1
Vomiting	20	19
Dehydration – Nil	12	14
Mild	14	13
Moderate	4	3
Sugar intolerance	9	8
Stool pathogen		
Salmonella spp	3	2
Shigella spp	1	2
E. coli	4	3
Rotavirus	8	6

Treatment

The infants were offered the rice starch ORS by the nursing staff who maintained strict intake and output charts. The response to treatment was evaluated by the general clinical condition, stool frequency, urine output and body weight. Persistent vomiting, progressive dehydration, poor urine output and weight loss > 5% of admission weight were defined as criteria for failure of oral rehydration and recourse to intravenous therapy. In infants with dehydration > 5% the respective ORS was administered as a continuous intragastric drip to ensure optimal intake of the ORS.

Results

Efficacy of WHO ORS versus rice starch ORS

All 60 infants in both groups responded to oral rehydration and were successfully regraded over 24-36 hours to a conventional milk formula or a special formula when acquired carbohydrate intolerance was present.

The weight gain after 24 hours of ORS therapy was marginally higher in the WHO ORS group than the rice ORS group but the difference was not statistically significant. Five infants from the WHO ORS group and one infant from the rice starch ORS group had hypernatremia 24 hours after rehydration. The mean increase in serum sodium ion levels following rehydration was higher in the WHO ORS group compared to the rice starch ORS. The difference was however not statistically significant. The results are summarised in Table II.

Discussion

The use of the standard WHO ORS in non choleragenic infantile diarrhoea has been shown to be

Table II
Clinical and biochemical profile of 60 infants 24 hours after rehydration with rice starch and glucose polyelectrolyte solution

Clinical parameters	Rice ORS	WHO ORS
No. of patients	30	30
No. of infants who gained weight	22	22
Mean weight gain (gm)	150 ± 175	164 ± 123*
Mean increase in Sodium ions mmol/L	4.7 ± 3.8	8.3 ± 8.7*
Mean increase in Potassium ions mmol/L	1.1 ± 0.9	0.9 ± 0.5
No. of infants with hypernatremia (Na+ > 145 mmol/L)	1 (145)	5 (145 – 149)
Mean frequency of stools	3.8 ± 2.7	6.5 ± 5
Mean duration of stay (days)	3.4 ± 1.8	5.5 ± 2

** Student t-test shows no significant difference (p < 0.01) between Rice oral rehydration salts (ORS) and WHO ORS.*

associated with a higher incidence of hypernatremia[4,7,8]. As a result, many centres now use a glucose electrolyte solution with a lower concentration ranging from 35-60 mmol/L[9,10].

Glucose-sodium co-transport system forms the basis for the active movement of glucose and sodium, followed passively by water across the mucosa[2]. Increasing the sodium ion concentration in the ORS causes increased water absorption by the enterocyte[11]. In moderate dehydration where further progression of the disease can result in life threatening consequences, rapid correction of rehydration is vital and in these situations the standard WHO ORS currently appears to be the ideal oral rehydrating solution. However, the present findings indicate that a rice starch ORS with a lower concentration of sodium (60 mmol/L) is as effective as the standard WHO ORS in correcting mild dehydration in non choleragenic infantile diarrhoea, with the added benefit of a lower risk of hypernatremia. Although rice starch low sodium ORS was effective in correcting moderate dehydration in 4 infants, the number studied is small to make valid comparison to the standard WHO ORS.

There are several reasons for the greater efficiency of rice starch over glucose in promoting sodium and water movement across the gut. Rice starch has a lower osmolality than glucose. Hence, the concentration of rice starch can be increased 4-5 fold without corresponding increases in osmolality. Intraluminal digestion of the rice cereal release glucose polymers which in turn will be hydrolysed to a large number of glucose molecules at the surface of the villus cells, whereupon they are instantly taken up by the co-transport carriers. While the small number of glucose molecules do not accumulate to increase osmolality (compared to the number of glucose molecules in the standard WHO ORS) they however rapidly enter the enterocyte with sodium ions which result in markedly accelerated movement of water from the lumen. This consequentially reduces the fluid loss in stools. Intraluminal hydrolysis of rice cereal also releases several amino acids. Amino acids with a high affinity for their respective carrier systems promote sodium ions and water absorption independently of glucose[2].

The sum total of these favourable factors conferred

by rice in facilitating sodium and water absorption appears to compensate for the lower sodium concentration of 60 mmol/L of sodium in the rice ORS.

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References

1. Hirschhorn N, McCarthy BJ, Ranney B, Hirschhorn MA, Woodward ST, Lacapa A, Cash RA and Woodward WE. Ad libitum oral glucose-electrolyte therapy for acute diarrhoea in Apache children. J Pediatr 1973;83 : 562-70.

2. Hirschhorn N and Greenough III WB. Progress in oral rehydration therapy. Scientific American 1991;264 : 16-22.

3. Iyngkaran N, Robinson MJ. A review of current concepts in acute gastroenteritis. Part II. J Singapore Paediatric Soc 1977;19 : 25-34.

4. Iyngkaran N, Abidin Z and Royan G. Oral rehydration in infantile diarrhoea. The optimum carbohydrate-electrolyte composition. In: New perspectives in infant nutrition and diarrhoea disease. Ed. N. Iyngkaran, 1981;198 : 491-6.

5. Molla AM, Sarker SA, Hossain M, Molla A and Greenough III WB. Rice powder electrolyte solution as oral therapy in diarrhoeal due to *Vibrio cholerae* and *Escherichia coli*. Lancet 1982;1 : 317-9.

6. Patra FC, Mahalanabis D, Jalan KN, Sen A and Banerjee P. Is oral rice electrolyte solution superior to glucose electrolyte solution in infantile diarrhoea? Arch Dis Child 1982;57 : 910-2.

7. Chatterjee A, Mahalanabis D, Jalan KN, Maitra TK, Agarwal SK, Sutta B, Khatna SP and Bagelin DK. Oral rehydration in infantile diarrhoea: controlled trial of a low sodium glucose-electrolyte solution. Arch Dis Child 1978;53 : 284-9.

8. Cleary TG, Cleary KR, DuPont HL, El-Malih GS, Kordy MI, Mohieldin MS, Shoukry I, Shukry S, Wyatt RG, Woodward WE. The relationship of oral rehydration solution to hypernatremia in infantile diarrhoea. J Pediatr 1981;99 : 739-41.

9. Finberg L. Oral electrolyte/glucose solution: 1984. J Pediatr 1984;105 : 939-40.

10. Fox R, Leen CLS, Dunbar EM, Ellis ME and Mandal BK. Acute gastroenteritis in infants under 6 months old. Arch Dis Child 1990;65 : 936-8.

11. Beaugerie L, Cosnes J, Verwaerde F, Dupas H, Lamy P, Gendre P and Quintrec YL. Isotonic high-sodium oral rehydration solution for increasing sodium absorption in patients with short-bowel syndrome. Aust J Clin Nutr 1991;53 : 769-72.