REVISTA ESPAÑOLA DE FISIOLOGÍA, 48 (3), 197-202, 1992

Glucose Absorption by the Interposed Colon Segment after Intestinal Resection

H. Plapler*, D. J. Fagundes, S. Goldenberg, N. F. Novo, Y. Juliano and D. Bekhor

Post-Graduate Course in Surgical Technique and Experimental
Surgery of Paulista School of Medicine
Rua Botucatu, 720 - Vila Clementino
CEP 04023 - São Paulo (Brazil)

(Received on August 30, 1991)

H. PLAPLER, D. J. FAGUNDES, S. GOLDENBERG, N. F. NOVO, Y. JULIANO and D. BEKHOR. *Glucose Absorption by the Interposed Colon Segment after Intestinal Resection.* Rev. esp. Fisiol., 48 (3), 197-202, 1992.

One of the proposed surgical treatments of Short Bowel Syndrome is the interposition of a distal colon segment between two portions of the remnant small intestine. This method proved to reverse the nutritional disorders caused by this morbid entity. Surgical technique consisted in an 80 % small bowel resection and the interposition of a 3 cm segment of distal colon between the remaining jejunum and ileum. After 70 days, the animals were reoperated and the interposed and the distal colon were isolated and tied. By using the method of rapid and successive absorptions of a glucose solution through the intestinal lumen, the relations between the absorption curves of the interposed and the normal colon could be dran. Results show that the interposed colon segment absorbs more glucose (mean = 1.43 ± 1.16 mg/dl) than the distal colon (mean = 0.37 ± 0.29 mg/dl) and that its absorption pattern is similar to the small bowel rather than the colon. These results allow the use of this method for further studies in which the interposed colon adaptation is studied with other nutrients and/or under specific conditions.

Key words: Glucose intestinal absorption, Intestine, Colon-surgery, Short bowel syndrome.

A few years ago, massive intestinal resection was a fairly option to treat some intestinal diseases due to its high mortality. Despite total parenteral nutrition (TPN) and other up-to-date clinical support, Short Bowel Syndrome (SBS) due to extensive small bowel resection still stands as a major challenge.

Clinical and experimental assays demonstrated, in certain degree, some aspects of morphofunctional adaptation of a distal colon segment interposed between the entire intestine after extensive small bowel resections.

Morphological changes were show to be

* To whom all correspondence should be addressed.

a as villi development on the interposed colon mucosa of dogs (7, 13) and rats (5, 12) but, although many authors have described improved absorption after colon interposition (2, 14, 15), nobody have proved that this segment itself could be directly involved.

By constructing an experimental model that relates glucose absorption between interposed and normal distal colon, it was possible to study this aspect of functional adaptation.

Materials and Method

Eleven female Wistar rats, 3 months old, weighing between 185 and 320 g were fasted for 24 hours before operative procedure. They were anesthetized with a sodium pentobarbital intraperitoneal injection and the entire intestine exposed from the duodenojejunal junction to the ileocecal valve. Eighty percent of this length was resected remaining 10 % of the proximal jejunum and 10 % of the distal ileum. A 3 cm length of distal colon was isolated after the left colic artery bifurcation and interposed between the remaining jejunum and ileum in an isoperistaltic fashion. All end-to-end anastomoses were done with 6.0 polypropilene suture. After 24 hours the animals were allowed access to normal chow pellets and water for 70 days.

At the 70th postoperative day they were reoperated and the interposed segment was identified. Cannulae were introduced into intestinal lumen of both segments (interposed and distal colon), as their tips were located just at the site of the anastomosis.

Perfusion was done as described before (6). By using a mechanical pump that works with constant pression rates (4), both segments were perfused 10 times separately with a 5 mM glucose solution at 20 ml/min flow rate for one minute. Between each perfusion set, segments were washed with normal saline (NaCl 0.9 %) and dried with air injections.

The samples were enclosed in individual bottles and glucose concentration analysis was carried out in a COBAS-MIRA analyser that uses a computorized method to measure glucose concentration with a confidence rate of 0.1 mg/dl.

The difference between initial and final concentration was regarded as glucose absorption by the intestinal segment (16).

Data were submitted to statistical analysis by Friedman's and Wilcoxon's tests (a = 5 %).

Results

Glucose absorption rates for each segment. — For each perfusion set the glucose absorption value was plotted individually in a spreadsheet and submitted to statistical analysis by FRIEDMAN's test. This analysis revealed that all the values for both groups were homogeneous. Therefore, even the variations observed in our data (tables I and II) did not affect the results.

Glucose absorption rates for each animal. — The mean value for glucose absorption for each animal was always higher for the interposed segment as compared to the colon distal segment. These data were submitted to statistical analysis by Wilcoxon's test which showed that these values were significantly higher for the interposed colon when compared to the distal segment (table III).

Discussion

Although many authors have described morphological (6, 9-13) and even functional (14) adaptation of the interposed colon, none of them have shown that this segment itself is responsible for those changes. The current trend is to believe

Table I. *Glucose absorption (mg/dl) by perfused interposed colon of rat.*

Rat	Absorption period									
	1	2	3	4	5	6	7	8	9	10
1	0.00	1.04	2.08	1.04	1.04	0.00	2.08	2.08	3.12	2.08
2	1.02	0.00	0.00	1.02	0.00	3.06	0.00	0.00	0.00	0.00
3	1.85	1.85	0.00	0.00	0.00	0.92	0.00	0.00	0.00	0.92
4	1.88	0.94	0.94	0.94	3.77	0.00	1.88	0.00	1.88	0.94
5	0.96	1.92	0.00	0.96	0.96	0.00	0.96	0.00	0.00	0.96
6	5.45	0.90	1.81	0.90	0.90	2.77	0.90	0.90	0.90	0.90
7	1.00	1.00	1.00	1.00	2.00	1.00	1.00	3.00	0.00	0.00
8	2.12	0.00	3.09	1.06	0.00	0.00	0.00	0.00	0.00	1.00
9	1.73	1.09	0.83	0.83	1.23	1.10	0.97	0.85	0.84	0.82
10	5.20	4.16	5.20	7.29	6.24	8.33	2.08	4.16	2.08	1.04
11	1.96	0.00	2.94	2.94	1.96	1.96	1.96	3.38	2.54	2.54

Table II. *Glucose absorption (mg/dl) by perfused remaining colon of rat.*

Rat	Absorption period									
	1	2	3	4	5	6	7	8	9	10
1	2.00	1.00	0.00	1.00	2.00	0.00	3.00	0.00	0.00	1.00
2	0.00	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	1.92	0.00	0.00	1.92	0.00	0.96	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.92	0.00	0.00	0.00	0.92	0.92	0.00	0.00	0.92	0.92
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	1.02	0.00	0.00	0.00	0.00	1.02
8	0.00	0.00	1.06	0.00	0.00	0.00	3.19	0.00	1.06	0.00
9	0.69	0.28	0.00	0.41	0.56	0.26	0.42	0.00	0.3	0.42
10	4.00	0.00	0.00	0.00	0.00	0.00	1.04	1.04	0.00	0.00
11	5.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

that the interposed colon acts as a mechanical break by delaying intestinal transit and by allowing the remnant small bowel to absorb more nutrients (3).

Morphological changes on the interposed colon mucosa, however, could point to functional modifications of this segment as well. For this study the interposed segment needs to be related to the remaining colon. This problem could be solved by the method of SOLS and PONZ (16).

Both interposed and distal colon segments showed that they are able to absorb glucose. As previously described (6), there is a descending absorption gradient from jejunum to colon, our data being tested against these values. The mean absorption rate was always higher for the interposed colon than for the distal colon.

As these segments were isolated from the intestinal transit during the perfusion, no interference could be expected from the small bowel in the absorption rates. The present results (table III) show that the absorption rates, expressed in mg/dl or in nM/cm/min, by the interposed colon are always higher than by the distal colon.

Table III. *Glucose absorption by interposed (a/A) and remaining (b/B) colon.* Values are expressed in mg/dl (mean ± SD) in a and b and in nmole/cm/min in A and B.

Rat	Interposed		Remaining	
	a	A	b	B
1	1.45 ± 1.00	2685	1.00 ± 1.00	1851
2	0.51 ± 0.99	944	0.09 ± 0.30	166
3	0.55 ± 0.77	1018	0.48 ± 0.81	888
4	1.31 ± 1.10	2425	0.00 ± 0.00	000
5	0.67 ± 0.64	1240	0.46 ± 0.48	851
6	1.63 ± 1.47	3018	0.00 ± 0.00	000
7	1.10 ± 0.80	2037	0.20 ± 0.43	370
8	0.73 ± 1.12	1351	0.53 ± 1.03	981
9	1.02 ± 0.28	1888	0.31 ± 0.22	574
10	4.57 ± 2.36	8648	0.60 ± 1.26	1111
11	2.21 ± 0.93	4203	0.50 ± 1.60	925
means+SD	1.43 ± 1.13*		0.37 ± 0.29	

* $p < 0.01$

This improvement in glucose absorption can be due to its increased absorption surface (12) showing the existence of functional changes besides morphological ones.

In previous works (6) we have shown that the interposed colon glucose absorption pattern is similar to the small bowel pattern, while the remaining distal colon has the same pattern as the normal colon.

This fact is relevant as the colon of newborn rats is able to absorb glucose but loses this capability after 3 weeks (1, 8). It is also known that, after a 70 % resection of the rat jejunoileum there is no glucose absorption either by the cecum or by the distal colon in its normal position (17).

Perhaps the new cellular groups that grow on the mucosa of the interposed segment are «young cells» with absorption capability as the newborn ones.

Efforts have now been done to demonstrate the same behavior of the interposed colon segments with other nutrients and under specific conditions.

This could be an evidence to keep colon interposition as a surgical treatment for Short Bowel Syndrome.

Acknowledgements

To Prof. M. C. Negrini-Fagundes for the text revision.

Resumen

Una de las posibilidades quirúrgicas para tratar el Síndrome de Intestino Corto es la interposición de un segmento de colon distal en el trayecto del intestino delgado. El método consiste en la resección del 80 % de yeyunoíleon y la interposición de 3 cm de colon distal. A los 70 días de la operación se reopera a los animales, introduciendo tubos de polietileno en el lúmen intestinal del colon interpuesto y del colon distal. Utilizando el método de absorciones rápidas y sucesivas de una solución de glucosa de concentración conocida (5 mM) por la luz intestinal, se establecen las curvas relativas de absorción para los diferentes segmentos de colon. Los resultados demuestran que el colon interpuesto absorbe más glucosa que el colon distal (medias de 1,43 ± 1,16 y 0,38 ± 0,29 mg/dl, respectivamente) y que el tipo de absorción es parecido al del intestino delgado. Estos resultados permiten que el método pueda ser utilizado en estudios posterio-

res de adaptación del colon interpuesto en la absorción de otros nutrientes.

Palabras clave: Absorción intestinal de glucosa, Intestino, Cirugía de colon, Síndrome de intestino corto.

References

1. Batt, E. R. and Schachter, D.: *Am. J. Physiol.*, 216, 1064-1068, 1969.
2. Belin, R. P., Richardson, J. D., Scott Medley, E., Beargie, R. A., Bryant, L. R., and Griffen Jr., W. O.: *J. Surg. Res.*, 3, 193-198, 1972.
3. Brolin, R. E.: *Surgery*, 47, 576-580, 1986.
4. Fagundes, D. J. and Plapler, H.: *Acta Cir. Bras.*, 4, 36-40, 1989.
5. Fagundes, D. J., Plapler, H. and Goldenberg, A.: *Acta Cir. Bras.*, 6, 21-31, 1991.
6. Fagundes, D. J. and Plapler, H.: *Rev. esp. Fisiol.*, 47, 129-132, 1991.
7. Faria Netto, A. J.: Tese-Mestrado-Escola Paulista de Medicina. São Paulo, 1978.
8. Heaton Jr., J. W.: *Am. J. Dig. Dis.*, 17, 7-16, 1972.
9. Lloyd, D. A.: *Br. J. Surg.*, 60, 904, 1973.
10. Lloyd, D. A.: *Prog. Pediatr. Surg.*, 12, 51-106, 1978.
11. Lloyd, D. A.: *J. Pediatr. Surg.*, 16, 64-69, 1981.
12. Plapler, H., Goldenberg, S., Faria Netto, A. J., Miszputen, S. J. and Saad, F. A.: *Rev. Col. Bras. Cir.*, 12, 200-204, 1985.
13. Schapiro, M.: Tese-Doutoramento-Escola Paulista de Medicina. São Paulo, 1974.
14. Sidhu, G. S., Narashimharao, K. L., Usha Rani, V., Sarkar, A. K., Chakravarti, R. N. and Mitra, S. K.: *Digestion*, 29, 47-54, 1984.
15. Sidhu, G. S., Narasimharao, K. L., Usha Rani, V. *et al.*: *Dig. Dis. Sci.*, 30, 483-488, 1985.
16. Sols, A. and Ponz, F.: *Rev. esp. Fisiol.*, 3, 207-211, 1947.
17. Urban, E., Starr, P. E., and Michel, A. M.: *Dig. Dis. Sci.*, 28, 265-272, 1983.