Effect of glucocorticoid treatment on glucose and glutamine metabolism by the small intestine of the rat

M. SALLEH M. ARDAWI*, MAY F. MAJZOUB† AND ERIC A. NEWSHOLME‡

*Department of Clinical Biochemistry and †King Fahd Medical Research Center, College of Medicine and Allied Sciences, King Abdulaziz University, Jeddah, Saudi Arabia, and ‡Department of Biochemistry, University of Oxford, Oxford, U.K.

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SUMMARY

1. The effect of dexamethasone (30 µg day⁻¹ 100 g⁻¹ body wt.) on the metabolism of glucose and glutamine was studied in the small intestine of rats after 9 days of treatment.

2. Dexamethasone treatment resulted in negative nitrogen balance (P < 0.001), and produced increases in the concentrations of plasma glucose (22%, P < 0.05), alanine (32%, P < 0.001) and insulin (127%, P < 0.001), but a decrease in the plasma concentration of glutamine (20%, P < 0.05).

3. Portal-drained visceral blood flow increased by approximately 22% (P < 0.001) in dexamethasone-treated rats, and was accompanied by a decrease in the arteriovenous concentration difference of glucose (43%, P < 0.001) and an increase in that of lactate (22%, P < 0.05), glutamine (35%, P < 0.01), glutamate (33%, P < 0.01) and alanine (21%, P < 0.05).

4. Enterocytes isolated from dexamethasone-treated rats showed decreased and increased rates of glucose and glutamine utilization, respectively.

5. The maximal activities of hexokinase, 6-phosphofructokinase, citrate synthase and oxoglutarate dehydrogenase were decreased (30–64%, P < 0.001) in intestinal mucosal scrapings of dexamethasone-treated rats, whereas the activity of glutaminase was increased (35%, P < 0.001).

6. It is concluded that glucocorticoid administration decreases the rate of glucose utilization but increases that of glutamine (both in vivo and in vitro) by the epithelial cells of the small intestine. This may be caused by changes in the maximal activities of key enzymes in the pathways of glucose and glutamine metabolism in these cells.

Key words: glucocorticoids, glucose, glutamine, metabolism, small intestine.

Abbreviation: PAH, p-aminobenzaldehyde.

INTRODUCTION

Catabolic disease states such as trauma, sepsis, major surgery, burns and uncontrolled diabetes are characterized by accelerated muscle proteolysis and translocation of amino acids from the periphery to the visceral organs (for reviews, see [1–3]). Glutamine and alanine account for more than half of the amino acids released by skeletal muscle during stress states and hence are the principal nitrogen carriers from the periphery to the visceral organs [4, 5].

The major site of utilization of glutamine in the nonhepatic splanchnic bed is the mucosa of the small intestine. Most of the energy required by these cells is provided by the oxidation of glucose and glutamine in the fed state and of glutamine and ketone bodies in the starved state (for review, see [5]).

The plasma level of glucocorticoids is increased in sepsis and other stress states [2]. Raising the plasma level artificially by administration of glucocorticoids increases glutamine utilization but decreases glucose utilization by the gut of dogs; this change is accompanied by an increased rate of hepatic gluconeogenesis [6]. Moreover, after laparotomy, the rate of glutamine utilization by the small intestine is elevated despite the fall in the plasma concentration of glutamine and the diminished intestinal blood flow [7].

Recently, it has been shown that thermal injury of rats (33% of body surface area) increases the rate of intestinal glutamine utilization and decreases that of glucose at 3 days after injury [8].

The present work was designed to determine the effects of the administration of glucocorticoids to normal rats on the rates of glucose and glutamine utilization by the small intestine. This has been carried out by measurement of arteriovenous concentration differences across the small intestine, which, together with blood flow data, allow calculation of the rates of utilization of these fuels in vivo. In addition, the rates of glucose and glutamine utili-