Journal of Equine Veterinary Science 34 (2014) 742–748

Contents lists available at ScienceDirect

Journal of Equine Veterinary Science

journal homepage: www.j-evs.com

Original Research

Comparison of Three Methods for Evaluation of Equine Insulin Regulation in Horses of Varied Body Condition Score

Heidi E. Banse DVM, PhD, DACVIM (LA) *, Dianne McFarlane DVM, PhD, DACVIM (LA)

Department of Physiology, Center for Veterinary Health Sciences, Oklahoma State University, Stillwater, OK

ARTICLE INFO

Article history:
Received 26 September 2013
Received in revised form 24 December 2013
Accepted 6 January 2014
Available online 10 January 2014

Keywords:
Hyperinsulinemic euglycemic clamp
Oral sugar test
Insulin response to dexamethasone test

ABSTRACT

Multiple dynamic field tests are used for assessment of equine insulin resistance or altered insulin regulation. However, the relationship between markers of glucose homeostasis and insulin disposal obtained by different testing protocols is unknown. We hypothesized that two recently developed field tests for evaluation of equine insulin dysregulation, the insulin response to dexamethasone test (IRDT) and oral sugar test (OST), would yield comparable results to the hyperinsulinemic euglycemic clamp (HEC). Fifteen light breed horses with body condition scores (BCS) 3 of 9 to 8 of 9 were used in this study. Eight horses (BCS, 5 of 9 to 7 of 9) underwent an OST under two different housing conditions, pasture, and stall (experiment 1). These eight horses also underwent an HEC and IRDT over a 4-week period (experiment 2), and results were compared with the OST stall. Finally, eight horses (BCS, 3 of 9 to 8 of 9), including one horse from experiments 1 and 2, underwent an OST on pasture three times over a 14–16-week period during the summer and the fall (experiment 3). The HEC did not correlate with either the OST or IRDT. The OST was not different when performed in the pasture compared within a stall but did change significantly over time on pasture. These results suggest that in insulin-sensitive horses, the OST and IRDT results are not primarily determined by tissue insulin sensitivity in horses of varying BCS. Furthermore, OST results may vary depending on pasture composition or season.

1. Introduction

Hyperinsulinemia is a recognized risk factor for the development of laminitis [1]. In horses presenting to a first-opinion hospital for evaluation of laminitis, 86% of horses were hyperinsulinemic [2]. Despite the clinical importance of hyperinsulinemia, there is no established standard for evaluation of insulin regulation in the horse. The presence of equine insulin dysregulation has been assessed by fasting hyperinsulinemia, proxies [3], or dynamic glucose or insulin tolerance testing [4–6]. In people, the gold standard for evaluation of tissue insulin sensitivity is the hyperinsulinemic euglycemic clamp (HEC) [7], a test that has been adapted for use in equids [8–12]. The HEC is ideal for assessing insulin sensitivity, as it assesses tissue insulin sensitivity isolated from the impact of pancreatic insulin secretion or enteral glucose absorption on glucose homeostasis [7]. However, the HEC requires use of infusion pumps and frequent monitoring and thus is not amenable to epidemiologic studies or field testing of client horses. Furthermore, the specificity of the HEC for insulin-sensitive tissues may be a disadvantage in cases where enteral glucose absorption or pancreatic response to glucose may be altered.

Several tests have been developed or adapted for use to improve ease of detection of insulin resistance or altered insulin regulation (insulin dysregulation) by equine practitioners. In general, these tests have been used interchangeably in practice to diagnose “insulin resistance”

* Corresponding author at: Dr Heidi E. Banse, Department of Veterinary Clinical and Diagnostic Sciences, Faculty of Veterinary Medicine, University of Calgary, 3280 Hospital Drive NW, Calgary, AB T2N 4Z6.
E-mail address: hebanse@ucalgary.ca (H.E. Banse).

0737-0806/$ – see front matter © 2014 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jevs.2014.01.001

despite an absence of data evaluating the equivalence of the tests in characterizing the nature or magnitude of response. The oral sugar test (OST) is a recently developed method for evaluation of insulin and glucose response to an oral sugar challenge, involving administration of corn syrup by mouth to horses followed by measurement of insulin and glucose at 60–90 minutes after administration [13]. The simplicity of the OST makes it an attractive possibility for ambulatory practice. However, because the response to an oral sugar challenge is influenced by enteral glucose absorption, pancreatic insulin secretion, and tissue insulin sensitivity, results may differ from the HEC.

Initial evaluation of the insulin and glucose response to an OST was performed in a controlled environment (fasted, in stalls) [14]. It is uncertain, how this test performs when horses are on pasture, which may introduce greater variability because of amount of grass consumed and nonstructural carbohydrate (NSC) content of pasture. In horses normally kept on pasture, altering housing may induce stress and alter test results. Thus, it is important to understand how environment impacts test results. Furthermore, with any oral glucose challenge test, it is likely that season will have an effect because of differences in NSC content of pasture and thus, NSC intake. Seasonal changes in pasture composition have been previously documented [15] and appear to influence fasting insulin concentrations [16,17].

The dexamethasone suppression test has historically been used to identify pituitary pars intermedia dysfunction [18]. However, it may also be useful in identification of insulin dysregulation. A previous report demonstrated that horses of body condition scores (BCS) 5–6 had a threefold increase in serum insulin concentration 24 hours after 0.04 mg/kg IV dexamethasone [19]. Furthermore, ponies predisposed to laminitis had higher insulin concentrations following intramuscular dexamethasone (0.04 mg/kg) compared with control ponies [20], although a recent study suggests this may not be consistent across season or year [21].

The purposes of this study were to compare the effect of altered housing on the OST (experiment 1) and to evaluate three different methods of insulin regulation testing (HEC, OST), and the insulin response to dexamethasone test (IRDT) in Quarter Horses of varying BCS (experiment 2). An additional objective was to evaluate the effect of season on the OST in horses maintained on pasture (experiment 3). We hypothesized that the HEC, OST, and IRDT results would be correlated.

2. Materials and Methods

All testing protocols were approved by the Oklahoma State University Institutional Care and Use Committee.

2.1. Experiment 1: Comparison of the OST Under Two Different Housing Conditions: Stall and Pasture

2.1.1. Horses

Eight Quarter Horses, aged 7–14 years and weighing 518–645 kg were used in this study. There were seven geldings and one mare. Body condition scores were 5 (n = 3), 6 (n = 2), and 7 (n = 3) of 9 [22]. Horses were free of clinical signs of systemic disease, including pituitary pars intermedia dysfunction. Two horses (BCS 5) had navicular disease. Horses were housed on pasture with free-choice grass hay. At the time of testing, pasture grass was green but not abundant, and it is estimated that about 50% of dietary intake came from pasture and 50% from hay.

2.1.2. Oral Sugar Tests

To evaluate the effect of diet and housing on OST results, OST was performed as previously described [13]. All OSTs were performed during a 4-week period between mid-October and mid-November. The order of OSTs was randomized, with four horses undergoing OST pasture first and four horses undergoing OST stall first. Oral sugar test pasture and OST stall for each horse were performed 24 hours apart. Horses undergoing OST stall were fasted for approximately 12 hours (one flake of hay after 10 PM) before initiation of the OST, as previously described [13]. Horses were weighed using an electronic scale on the day of testing. Blood samples were collected at baseline and 75 minutes after administration of corn syrup (Karo Light; ACH Food Companies, Inc., Memphis, TN) at 0.15 mL/kg, PO. Blood glucose was analyzed immediately via a handheld glucometer (AlphaTRAK; Abbott Laboratories, Abbott Park, IL) that has been previously validated in the horse [23]. After analysis of blood glucose, blood samples were placed on ice for approximately 12 hours until centrifuged at 1700*g* for 15–20 minutes. Serum was stored at −80°C for analysis of insulin concentration by radioimmunoassay (Coat-A-Count; Siemens, Tarrytown, NY) [24]. Horses were considered to be insulin sensitive if fasting (insulin T0) was <143.5 pmol/L [25] and insulin T75 was <430 pmol/L [13].

2.1.3. Statistical Analysis

The blood glucose and insulin concentrations 75 minutes after initiation of the OST for OST pasture and OST stall were compared by a paired *t* test to determine repeatability.

2.2. Experiment 2: Comparison of HEC, OST, and IRDT

2.2.1. Horses

The horses for this experiment were the same as those used in experiment 1. Horses were housed on pasture with free-choice grass hay.

2.2.2. Morphometrics

Height at withers, length, heart girth, abdominal girth [26], and neck circumference [27] were measured, and body mass index (BMI) was calculated as previously described [28], using the following formula: BMI = weight (kg)/height (m^2).

2.2.3. Dynamic Insulin Sensitivity Testing

Over a 4-week period, all horses underwent an OST, while stalled (as part of experiment 1, OST stall), HEC, and IRDT. The HEC was performed 36–48 hours after the OST. All horses were given at least a 7-day washout period between the IRDT and any other dynamic test. Horses were allowed grass hay when undergoing the HEC, whereas horses were on pasture for the IRDT.