Available online at www.sciencedirect.com

SciVerse ScienceDirect

Theriogenology

Theriogenology 77 (2012) 818–828

www.theriojournal.com

Review

The mare: A 1000-pound guinea pig for study of the ovulatory follicular wave in women

O.J. Ginther[a,b,*]

[a] *Eutheria Foundation, Cross Plains, Wisconsin, USA*

[b] *Department of Pathobiological Sciences, School of Veterinary Medicine, University of Wisconsin, Madison, Wisconsin, USA*

Received 4 August 2011; received in revised form 20 September 2011; accepted 20 September 2011

Abstract

The mare is a good comparative model for study of ovarian follicles in women, owing to striking similarities in follicular waves and the mechanism for selection of a dominant follicle. Commonality in follicle dynamics between mares and women include: (1) a ratio of 2.2:1 (mare:woman) in diameter of the largest follicle at wave emergence when the wave-stimulating FSH surge reaches maximum, in diameter increase of the two largest follicles between emergence and the beginning of deviation between the future dominant and subordinate follicles, in diameter of each of the two largest follicles at the beginning of deviation, and in maximum diameter of the preovulatory follicle; (2) emergence of the future ovulatory follicle before the largest subordinate follicle; (3) a mean interval of 1 day between emergence of individual follicles of the wave; (4) percentage increase in diameter of follicles for the 3 days before deviation; (5) deviation 3 or 4 days after emergence; (6) 25% incidence of a major anovulatory follicular wave emerging before the ovulatory wave; (7) 40% incidence of a predeviation follicle preceding the ovulatory wave; (8) small but significant increase in estradiol and LH before deviation; (9) cooperative roles of FSH and insulin-like growth factor 1 and its proteases in the deviation process; (10) age-related effects on the follicles and oocytes; (11) approximate 37-hour interval between administration of hCG and ovulation; and (12) similar gray-scale and color-Doppler ultrasound changes in the preovulatory follicle. In conclusion, the mare may be the premier nonprimate model for study of follicle dynamics in women.

Keywords: Age; Ovarian follicles; FSH; Mare; Women

Contents

1. Introduction 819
2. Comparative research 819
3. Applied spin-off to the horse industry 819
4. Advantages of the mare as a follicle-research model 820
5. Follicular waves 820
6. Hormonal control of follicular waves 821
7. Effects of aging on follicles and oocytes 823
8. Periovulatory period 824
9. Conclusions 826

* Corresponding author. Tel.: +1 608 798 3777; fax: +1 608 798 3722.
E-mail address: ginther@vetmed.wisc.edu (O.J. Ginther).

0093-691X/$ – see front matter © 2012 Elsevier Inc. All rights reserved.
doi:10.1016/j.theriogenology.2011.09.025

Acknowledgments 826
References 826

1. Introduction

Webster's two definitions of guinea-pig are: (1) a short-eared tailless rodent, and (2) a subject used for research. The second definition and the past and potential future contributions of the mare to follicle research account for the title of this review. The horse has done and is still doing a lot for mankind, but the role of the horse in advancing knowledge on the mechanisms of basic reproductive events for consideration in humans and other species is not widely known.

This review discusses the following: (1) comparative research among species; (2) benefits that accrue to the equine industry when the mare is used as a comparative basic research model; (3) advantages of the mare as a research model; (4) similarities and dissimilarities between mares and women in the dynamics of the ovulatory follicular wave and the deviation in growth rates between the future dominant and largest subordinate follicle; (5) similarities and dissimilarities in the hormonal regulation of follicular waves; (6) use of the mare as a comparative model for studying the effects of aging on the ovulatory follicular wave and oocytes; and (7) similarities and dissimilarities in the preovulatory follicle and ovulation and associated hormone concentrations.

2. Comparative research

Comparative research among species involves studying the nature of a biological mechanism by using a species with certain research advantages to obtain preliminary knowledge for other species and especially for species in which research may be difficult or impractical. As an example of comparative research, consider the passage of an egg from the ovary to the uterus through the oviduct. In all common mammals, except the horse, both fertilized and unfertilized eggs enter the uterus. The mare is different in that the fertilized egg enters the uterus, but the unfertilized egg is trapped in the oviduct where it degenerates [1]. It may degenerate over many months or occasionally may be carried into the uterus with a fertilized egg [2]. This unique equine phenomenon was the impetus for the discovery in a nonequine species that the sojourn of the fertilized egg through the oviduct is more rapid than for the unfertilized egg [3]. Thus, a profound mechanism in the mare led to the discovery of a similar but more subtle mechanism in another species. Further studies in the mare unraveled the mechanism whereby the fertilized egg controls its own passage through the oviduct [4]. This fundamental discovery and elucidation opened an area of investigation for other species, including humans—thanks to the mare.

3. Applied spin-off to the horse industry

Humans are often the beneficiary of comparative research, so much so that the National Institutes of Health (NIH) and other granting agencies encourage and provide funding for research in laboratory and farm species, even though the National Institutes of Health mission concerns the biology of humans. Basic research with the equine model may be funded by agencies outside of the equine industry, but the resulting contribution to basic knowledge may carry with it considerable applied spin-off for the equine industry. Thus, the horse is a direct beneficiary of comparative basic research with the horse model.

Some basic discoveries with the horse model are used directly by the horse industry. For example, comparative studies between cattle and horses resulted in the basic discovery of equine embryo intrauterine mobility [5]. This discovery in turn advanced the procedures for ultrasonic diagnosis of equine pregnancy; [6] led to the widely used transrectal technique for eliminating one member of a twin set; and [7] explained many previously perplexing phenomena, including the ability of a small embryo in a large uterus to block the systemic pathway for uterine-induced luteolysis, the factors that determine the intrauterine site of embryo fixation (cessation of mobility), and the mechanism used by the mare for eliminating one member of a twin set [8,9]. Other discoveries with the horse research model are the impetus for subsequent studies on the optimal applied use of the basic finding. For example, the basic finding [10,11] that mare follicles are responsive to treatment with pituitary preparations for inducing ovulation or superovulation, even during the anovulatory season, led to the development of various applied protocols, especially for embryo transfer purposes [12,13]. It seems safe to say that most modern reproductive procedures and treatments currently used on horse breeding farms evolved from basic research.