FROM OVULATION TO IMPLANTATION

FROM OVULATION TO IMPLANTATION

Proceedings of the VIIth Reinier de Graaf Symposium,
Maastricht, the Netherlands, 30 May–2 June 1990

Editors:

J.L.H. EVERS

Department of Obstetrics and Gynaecology
Academisch Ziekenhuis Maastricht
The University of Limburg
Maastricht, The Netherlands

M.J. HEINEMAN

Department of Obstetrics and Gynaecology
De Wever Hospital
Heerlen, The Netherlands

Co-editors:

J.A. BROSENS
Leuven, Belgium

R. ROLLAND
Nijmegen, The Netherlands

F.J.C.M. FAUSER
Rotterdam, The Netherlands

J. SCHOEMAKER
Amsterdam, The Netherlands

Th.A.M. KRUIP
Utrecht, The Netherlands

A.G.H. SMALS
Nijmegen, The Netherlands

E-M 1990

EXCERPTA MEDICA, Amsterdam – New York – Oxford

International Congress Series No. 917
ISBN 0 444 81122 2

This book is printed on acid-free paper.

Published by:
Elsevier Science Publishers B.V.
(Biomedical Division)
P.O. Box 211
1000 AE Amsterdam
The Netherlands

Sole distributors for the USA and Canada:
Elsevier Science Publishing Company Inc.
655 Avenue of the Americas
New York, NY 10010
USA

Library of Congress Cataloging in Publication Data:

Reinier de Graaf Symposium (7th ; 1990 ; Maastricht, Netherlands)
From ovulation to implantation : proceedings of the VIIth Reinier de Graaf Symposium, Maastricht, the Netherlands, 30 May-2 June 1990 / editors, J.L.H. Evers, M.J. Heineman ; co-editors, I.A. Brosens ... [et al.].
p. cm. -- (International congress series ; no. 917)
Includes indexes.
ISBN 0-444-81122-2 (alk. paper)
1. Ovulation--Congresses. 2. Ovum implantation--Congresses. I. Evers, Johannes Leonardus Henricus, 1949- . II. Heineman, Maas Jan, 1952- . III. Title. IV. Series.
[DNLM: 1. Embryo Transfer--congresses. 2. Fallopian Tubes--physiology--congresses. 3. Fertilization--congresses. 4. Ovulation--congresses. 5. Ovum Implantation--congresses. W3 EX89 no. 917 / WQ 205 R367 1990f]
QP261.R38 1990
599'.0166--dc20
DNLM/DLC
for Library of Congress 90-13941
CIP

Printed in The Netherlands

VIIth REINIER DE GRAAF SYMPOSIUM

FROM OVULATION TO IMPLANTATION

Local Organizing Committee

Dr P.X.J.M. BOUCKAERT
Dr G.A.J. DUNSELMAN
Prof. Dr J.L.H. EVERS
Dr M.J. HEINEMAN
Dr J.A. LAND

THE REINIER DE GRAAF SYMPOSIA

I	1973	Noordwijkerhout	The contributions of Reinier de Graaf to reproductive biology
II	1975	Amsterdam	Corpus luteum function
III	1978	Maastricht	Non-luteal ovarian function throughout life
IV	1981	Nijmegen	Follicular maturation and ovulation
V	1984	Nijmegen	Gamete quality and fertility regulation
VI	1987	Nijmegen	Neuro-endocrinology of reproduction
VII	1990	Maastricht	From ovulation to implantation

LIST OF INVITED SPEAKERS

AITKEN, ROBERT J.
MRC Unit of Reproductive Biology
37 Chalmers Street
Edinburgh EH3 9EW
United Kingdom

BAIRD, DAVID T.
Dept. Obstetrics and Gynaecology
University of Edinburgh
Centre for Reproductive Biology
37 Chalmers Street
Edinburgh EH3 9EW
United Kingdom

BEIER, HENNING M.
Dept. Anatomy and Reproductive Biology
RWTH
Pauwelsstrasse
D-5100 Aachen
Federal Republic of Germany

BICSAK, THOMAS
The Whittier Institute for Diabetes and Endocrinology
9894 Genesee Avenue
La Jolla
California 92037
USA

BOIME, IRVING
Dept. Pharmacology and OB/GYN
Washington University School of Medicine
Box 8103
660 South Euclid Avenue
St. Louis
Missouri 63110
USA

BRAUDE, PETER
Dept. Obstetrics and Genaecology
University of Cambridge Clinical School
The Rosie Maternity Hospital
Robinson Way
Cambridge CB2 2SW
United Kingdom

BROSENS, IVO A.
Afd. Gynaecologie en Verloskunde
Academisch Ziekenhuis De Gasthuisberg
Katholieke Universiteit Leuven
Belgium

COHEN, JACQUES
Center for Reproductive Medicine and Infertility
Cornell University Medical College
HT-330
505 East 70th Street
New York, New York 10021
USA

COOKE, IAN D.
Dept. Obstetrics and Gynaecology
Jessop Hospital for Women
The University of Sheffield
Sheffield S3 7RE
Sheffield
United Kingdom

HANEY, ARTHUR F.
Duke University Medical Center
Box 2971
Durham
North Carolina 27710
USA

HUNTER, ROBERT H.F.
Faculty of Veterinary Medicine
(CRRA)
University of Montreal
CP 5000
Saint Hyacinthe
Quebec J2S 7C6
Canada

LAND, JOLANDE A.
Dept. Obstetrics and Gynaecology
Academisch Ziekenhuis Maastricht
P.O. Box 1918
6201 BX Maastricht
The Netherlands

LEESE, HENRY J.
Dept. Biology
University of York
York Y01 5DD
United Kingdom

LENZ, SUZAN
Dept. Obstetrics and Gynaecology
Rigshospitalet
Blegdamsvej 9
DK-2100 Copenhagen
Denmark

LINDENBERG, SVEND
Dept. Obstetrics and Gynaecology
Rigshospitalet
Blegdamsvej 9
DK-2100 Copenhagen
Denmark

MOOR, ROBERT M.
AFRC Institute of Animal
Physiology and Genetics Research
Cambridge Research Station
Babraham Hall
Cambridge CB2 4AT
United Kingdom

TESARIK, JAN
Unite Inserm 187
32, Rue de Carnets
92140 Clamart
France

WASSARMAN, PAUL M.
Dept. Cell & Developmental Biology
Roche Institute of Molecular Biology
Roche Research Centre
Nutley
New Jersey 07110
USA

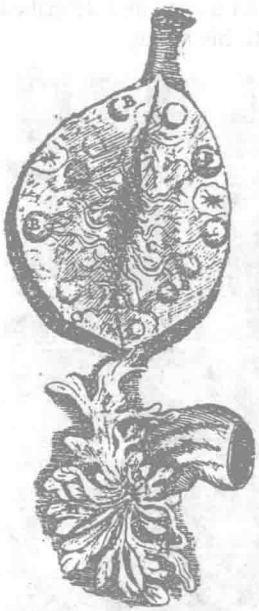
PREFACE

Reinier de Graaf (1641–1673) was one of a group of young Dutch physicians and anatomists who provided evidence that the *'female testis'*, appropriately named *ovarium* by Fabricius, is a pivotal organ for reproductive function in the female. In his *'De mulierum organis generationi inservientibus tractatus novus'* Reinier de Graaf indicated that this organ is indeed an ovary, and described for the first time the follicles which are now associated with his name.

Fig. 1: Reinier de Graaf dissecting a corpse in his study (detail of a drawing by J. Verkolje; Museum Boymans-van Beuningen, Rotterdam, with permission).

However, de Graaf contributed more to our knowledge than the Graafian follicle. In his *'De viorum organis generationi inservientibus'* he drew attention to the functional anatomy of the male reproductive organs.

In one of the less known sections of his work he described the discovery of a tubal ovum, and advanced evidence that embryonic development starts already in the Fallopian tube. Reinier de Graaf reported, in 1672, his studies of the contents of the rabbit oviduct at different intervals after copulation. He discovered no eggs in the oviducts of animals killed during the first two days following mating, but on the third day he found little spheres, which appeared to have migrated to the uterine cavity on the subsequent day. When he died at the age of only 32 years at Delft, Reinier de Graaf had shown his genius by contributing important observations on the role of the ovary and the testis in reproduction, on the ovum and its transport through the Fallopian tube to the uterus, and on that glandular substance in the ovary which he named *'corpus luteum'*.



TABULA DECIMA-SEXTA

EXHIBET TESTICULUM SEU OVARIUM MULIERIS CUM ANNEXO TUBARUM EXTREMO.

Fig. 2: Female internal genital organs as depicted by de Graaf in his 'De mulierum organis generationi inservientibus tractatus novus'.

To commemorate de Graaf, the *Reinier de Graaf symposia* have been organized in the Netherlands since 1973. Over the years, they have grown to become a forum for the mutual exchange of knowledge between clinicians and scientists in the rapidly expanding practice of clinical reproductive medicine and biology. After Noordwijkerhout (1973), Amsterdam (1975), Maastricht (1978), Nijmegen (1981, 1984,

and 1987) the 7th Reinier de Graaf symposium focused on the theme *'From ovulation to implantation'*, for the second time in Maastricht, from May 30 till June 2, 1990.
Topics discussed were: the mechanism of ovulation, fertilization, gamete and embryo transport and development in the Fallopian tube and in the peritoneal environment, corpus luteum function and implantation.

This book offers an account of the state of the art lectures presented by leading authorities of international acclaim at this symposium and of selected free communications and poster presentations. It puts on record the most recent developments in this fascinating field of reproductive research that was inspired by Reinier de Graaf, now more than 300 years ago.

We have to thank so many people for their help. Our colleagues in the local organizing committee, Peter Bouckaert, Gerard Dunselman and Jolande Land made it into a sheer pleasure to organize this symposium. We thank the authors for delivering their contributions so promptly as to make the rapid publication of this volume possible. We are indebted to Liesbeth Eichelsheim for her organizational skills and her excellent managing assistance, and to Nicolle Sangers-Jeurissen and Ria Huppertz for their secretarial help. The organization of this 7th Reinier de Graaf symposium has been made possible by an educational grant from Wyeth laboratories.

Maastricht, August 1990

J.L.H. Evers
M.J. Heineman

CONTENTS

THE 'REINIER DE GRAAF LECTURE'

The selection of the follicle of the month
D.T. Baird 3

THE 'NEW DEVELOPMENTS LECTURE'

Expression of recombinant human FSH and LH in mammalian cells: A source of potential agonists and antagonists for controlling fertility
I. Boime, J. Keene, M.M. Matzuk, P. Lapolt and A.J.W. Hsueh 23

THE 'STATE OF THE ART LECTURE'

The endometrial implant
I. Brosens 37

OVULATION AND THE MECHANISM OF FOLLICLE RUPTURE

The role of proteolysis in follicular development and ovulation
T.A. Bicsak 49

Clinical aspects of ovulation
I.D. Cooke, T.C. Li, B. Dunphy, P. Dockery, E. Lenton, S. Ramsewak and L. Klentzeris 63

Ultrasonographic visualization of human ovulation
R.A. Pierson, S.D. Martinuk, D.R. Chizen, C.W. Simpson 73

Structure and ultrastructure of human preovulatory oocytes immediately before the administration of hCG
O. Bomsel-Helmreich, I. Durand-Gasselin, G. Pennehouat, N. Vu, J.M. Antoine and J. Salat-Baroux 81

Follicular and oocyte maturation at 24–26 hours after preovulatory LH-peak in cows treated for superovulation
F. de Loos, M.M. Bevers, S.J. Dieleman and Th.A.M. Kruip 91

Asynchronous appearance of embryonic cardiac activity in multiple pregnancies following in vitro fertilisation
R. Schats 95

FALLOPIAN TUBE FUNCTION

Physiology of the fallopian tubes, with special reference to gametes, embryos and micro-environments
R.H.F. Hunter 101

Physiology of the fallopian tube: The provision of nutrients for oocytes and early embryos
H.J. Leese 121

Clinical aspects of fallopian tube function
J.A. Land 127

Tubal function: Role of myosalpinx
B. Karbowski, H.P.G. Schneider 139

Immunofluorescent studies on hamster oocyte activation
M.J. Sinosich, S.E. Lanzendorf, G.D. Hodgen and D.M. Saunders 145

Insulin reversibly inhibits rat blastocyst development in vitro
R. de Hertogh, I. Vanderheyden, S. Pampfer, D. Robin and E. Dufrasne 151

Time-dependent mRNA and protein requirements for meiotic maturation of bovine oocytes in vitro
P.M.M. Kastrop, S.C.J. Hulshof, M.M. Bevers, O.H.J. Destree and Th.A.M. Kruip 159

GAMETES AND EMBRYOS IN THE REPRODUCTIVE TRACT AND IN THE PERITONEAL ENVIRONMENT

Cell biology of the human spermatozoon
J. Aitken 167

Somatic cell interactions in early mammalian development
R.M. Moor, T. Nagai and F. Gandolfi 177

The peritoneal environment and infertility
A.F. Haney 193

Prediction of implantation before embryo transfer
K. Sheth, R. Parhar, Sultan Al-Sedairy, C. Hamilton, G. Roca and F. Al-Abdul Jabbar 203

Evidence for the existence of a pure corpus luteum deficiency
J.H. Check, J.S. Chase and H.G. Adelson 211

Retrograde menstruation is a more important factor in altering the intraabdominal milieu than the peritoneal endometrial implant
G.A.J. Dunselman, J.C.M. Dumoulin, J.A. Land and J.L.H. Evers 217

Clinical use of couple specific interaction tests: Peritoneal sperm migration and sperm survival in peritoneal fluid in vitro
M.A.H.M. Wiegerinck, J.G.M. Derksen, E. Moret, Y.A.J.M. Dabekaussen, G. Jansen and A.C. Booy 223

Effects of opioids on development of preimplantation mouse embryos
A.E. Kalyuzhny, O.V. Mironova, E.S. Platonov and G.T. Sukhikh 231

CONCEPTION

Zona pellucida glycoproteins: Regulators of mammalian fertilization
P.M. Wassarman 239
The development of the human preimplantation embryo
P.R. Braude, S.J. Pickering, N.J. Winston, J.K. Artley and M.H. Johnson 251
Biology of human fertilization: The general and the special
J. Tesarik 263

BIOLOGY OF IMPLANTATION

Embryo-endometrium interaction
S. Lindenberg, S. Kimber and L. Hamberger 285
Co-culture of mammalian embryos
K.E. Wiemer and J. Cohen 297
Capsules for intrauterine incubation of oocytes and spermatozoa and subsequent spontaneous release of embryos
S. Lenz 309

SELECTED POSTERS

Domain specific membrane fusion of phospholipid vesicles with bovine spermatozoa
E. Arts, D. Hoekstra and S. Jager 315
Labeling the bovine sperm surface and characterization of the plasma membrane protein composition with the biotin-avidin system
E. Arts, J. Kuiken and S. Jager 323
Micro-insemination of mouse oocytes
J.J.C.M. van de Leur and G.H. Zeilmaker 331
Relation between number of transfered embryos, embryo quality and pregnancy outcome in IVF
N. Naaktgeboren, A. v.d. Berg-Helder, F. Broers, K. v.d. Zwan, R. v.d. Weiden and F.M. Helmerhorst 337
Fluorescein diacetate assessment of embryo viability after ultrarapid freezing of human multipronucleate embryos
V. Noto, R. Campo, P. Roziers and S. Gordts 343
Intra vaginal culture (IVC), the Eindhoven experience
M.A.H.M. Wiegerinck, E. Moret, P.A. van Dop, M. Wijnberg and C.D.M.G. Beerendonk 349
Fertilization, implantation and pregnancy outcome in couples with male and tubal infertility: A three year survey
H. Tournaye, M. Camus, C. Staessen, N. Bollen, P. Devroey and A.C. Van Steirteghem 353

Index of authors 359

Subject index 361

THE 'REINIER DE GRAAF LECTURE'

From Ovulation to Implantation. J.H.L. Evers and M.J. Heineman, editors.

THE SELECTION OF THE FOLLICLE OF THE MONTH

DAVID T. BAIRD

Department of Obstetrics and Gynaecology, University of Edinburgh, Centre for Reproductive Biology, 37 Chalmers Street, Edinburgh EH3 9EW (UK)

INTRODUCTION

In all mammals a very small minority of the oocytes formed during fetal life are eventually ovulated[1]. The mechanism by which these lucky few survive the winnowing process of atresia is still unknown although it is clearly essential that in each species the number of eggs ovulated match the number of offspring which can be supported throughout pregnancy and infancy. Thus in primates a single offspring has a much better chance of surviving and there are evolutionary selection pressures to favour the emergence of a single ovulatory follicle. In many domestic animals, eg. sheep, man has selected strains with high ovulation rates for commercial purposes and it is possible within the same species to study animals with ovulation rates ranging from one to six[2,3,4]. In rodents on the other hand, there are advantages to producing larger litters and, hence, mice and rats have evolved a mechanism by which up to 12 preovulatory follicles develop.

In this paper I will consider this mechanism of selection of the preovulatory follicle(s) in primates including man and sheep. While the monovulatory status of primates and sheep makes them good models for man, much of our fundamental knowledge about the dynamics of oogenesis and particularly the mechanism of cellular differentiation of the follicle arise from rodent models[5,6,7]. The growth and differentiation of the follicle is designed to ensure that a mature healthy oocyte capable of being fertilized is ovulated at the appropriate time. Throughout folliculogenesis important maturational changes occur in the oocyte which ensure that by the time of ovulation the egg is capable of being fertilized. The somatic cells of the follicle (granulosa and theca) play an essential role in this maturation but this process is outside the scope of this present review.

Two main hypotheses have been developed to explain the process of follicle selection[8,9]. One theory supposes that waves or cohorts of follicles leave the pool of primordial follicles and that the follicle which will ovulate has already been predetermined during the process oogenesis. The second hypothesis assumes that recruitment from the pool of primordial follicles