

# Obstetric Brachial Plexus Lesions

– a framework for therapy –

PROEFSCHRIFT

ter verkrijging van de graad van Doctor

aan de Universiteit Leiden,

op gezag van Rector Magnificus Prof.mr. P.F. van der Heijden,

volgens besluit van het College voor Promoties

te verdedigen op woensdag 15 februari 2012

klokke 15:00 uur

door

Willem Pondaag  
geboren te Utrecht  
in 1972

**Promotiecommissie:**

Promotor:

Prof. dr. M.J.A. Malessy

Overige leden:

Prof. dr. O.F. Brouwer, Universitair Medisch Centrum Groningen

Prof. H.M. Clarke, University of Toronto, Canada

Prof. dr. J.G. van Dijk

Prof. dr. R.G.H.H. Nelissen

Dr. W.J.R. van Ouwkerk, Vrije Universiteit Medisch Centrum

Prof. dr. W.C. Peul

Prof. em. dr. R.T.W.M. Thomeer

Prof. dr. J. Verhaagen, Nederlands Instituut voor Neurowetenschappen

Financial support for the printing of this thesis has been generously provided by the Department of Neurosurgery LUMC, Braun, Biomet, Implantcast, Nycomed, Zeiss.

CIP-GEGEVENS KONINKLIJKE BIBLIOTHEEK, DEN HAAG

© Willem Pondaag.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanic, photocopying, recording or otherwise, without prior permission of the author.

ISBN 978-94-6191-151-3

Design and lay-out and by Textcetera, The Hague.

Printed by Ipskamp Drukkers BV, Enschede.

# Contents

Aim and outline	7
<b>Part 1 Introduction</b>	<b>9</b>
Chapter 1 General introduction to relevant aspects of nerve lesions, with special emphasis on OBPL	11
Chapter 2 Nerve surgery for OBPL. A historic overview	29
Chapter 3 Conservative versus surgical therapy of OBPL. A review focussed on scientific validation	39
<b>Part 2 Origin of OBPL and natural history</b>	<b>57</b>
Chapter 4 Correlating birthweight with neurological severity of obstetric brachial plexus lesions	59
Chapter 5 The natural history of OBPL. A systematic review	71
<b>Part 3 Electrophysiological support for prognosis and diagnosis</b>	<b>89</b>
Chapter 6 A review of electromyography in OBPL	91
Chapter 7 Severe obstetric brachial plexus lesions can be identified at one month of age	109
Chapter 8 Intraoperative NAP en CMAP recordings in patients with obstetric brachial plexus lesions	121
Chapter 9 Electromyography, nerve action potential and compound motor action potentials in OBPL. Validation in the absence of a gold standard	139
<b>Part 4 Results of nerve surgery</b>	<b>155</b>
Chapter 10 External rotation as a result of suprascapular nerve neurotization in obstetric brachial plexus lesions	157
Chapter 11 Recovery of hand function following nerve grafting and transfer in obstetric brachial plexus lesions	171
Chapter 12 Intercostal and pectoral nerve transfers to reinnervate the biceps muscle in obstetric brachial plexus lesions	187
Chapter 13 Results of end-to-side nerve coaptation in severe obstetric brachial plexus lesions and a review of the literature	199
<b>Part 5 Discussion</b>	<b>213</b>
Chapter 14 Summary and Discussion	215
Chapter 15 Nederlandse samenvatting. (Summary in Dutch)	247
List of publications	259
Dankwoord	261
Curriculum Vitae	263



## Aim and outline

The aim of this thesis is to provide a conceptual framework for treatment of infants with an obstetric brachial plexus lesion (OBPL).

OBPL is a closed traction injury of a complex peripheral nerve network resulting in function loss of the upper limb which may be permanent. A large number of papers and books have been published on the subject. These papers, however, do not provide an unequivocal set of guidelines for treatment. Although progress has been made over the past years, many unanswered questions remain. The most important primary questions are 1) can nerve surgery improve functional outcome of OBPL patients, 2) how should OBPL patients be selected for nerve surgery, and 3) which surgical strategy will lead to the best result.

In order to answer these three primary questions, a number of secondary questions first need to be addressed: a) what is in actual fact the natural history of OBPL, b) can ancillary investigation, in particular electromyography, aid in selection for surgery, c) what is the value of intra-operative electrodiagnostics, d) what are the detailed results of currently performed nerve surgical techniques, e) is a specific nerve reconstruction technique superior compared to another.

The results presented in this thesis are largely based on research into our own patient cohort carried out at the Leiden University Medical Centre's Department of Neurosurgery which serves as a tertiary referral centre in the Netherlands. Each year, 50-70 new infants with OBPL are evaluated at the outpatient clinic by a multidisciplinary team. Of these, 25-35 are treated with nerve surgery. This thesis presents an analysis of the LUMC experience.

Part 1 consists of three chapters. First, a general introduction to nerve lesions, nerve surgery and OBPL. Second, a historical overview of OBPL and its surgical treatment. Third, a critical analysis of the criteria advocated by different surgeons for selecting OBPL patients for nerve surgical treatment. Part 2 looks at the origin of the lesion and its natural history. Obstetric factors related to the severity of OBPL in the LUMC patient cohort are described. In addition, a systematic literature review of the natural history is presented. Part 3 evaluates the use of electrodiagnostic studies in the pre-operative and intra-operative assessment of lesion severity and its caveats. Part 4 consists of four outcome studies of nerve surgery. Three chapters describe results of the LUMC patient cohort, and one chapter presents the results of an innovative technique performed by Prof Gilbert, one of the OBPL pioneers.

In Part 5, all chapters will be summarized and discussed against the scientific background.