

University of Groningen

New insights into the surgical treatment of mitral regurgitation

Bouma, Wobbe

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version

Publisher's PDF, also known as Version of record

Publication date:

2016

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Bouma, W. (2016). *New insights into the surgical treatment of mitral regurgitation*. Rijksuniversiteit Groningen.

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

New Insights into the Surgical Treatment of Mitral Regurgitation

Wobbe Bouma

2016

CIP-GEGEVENS KONINKLIJKE BIBLIOTHEEK, DEN HAAG

Bouma, W.

New insights into the surgical treatment of mitral regurgitation.

Proefschrift Groningen. Met literatuuropgave en samenvatting in het Nederlands.

ISBN: 978-90-367-8713-0 (printed version)

ISBN: 978-90-367-8714-7 (digital version)

© Copyright 2016 W. Bouma

All rights are reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, mechanically, by photostopping, recording, or otherwise, without the written permission of the author.

Cover design: Bouma CTC, Cover Art and Design

Lay-out: Bouma CTC, Cover Art and Design

Printed by: Drukkerij Gildeprint, Enschede, the Netherlands



**rijksuniversiteit
groningen**

New Insights into the Surgical Treatment of Mitral Regurgitation

Proefschrift

ter verkrijging van de graad van doctor aan de
Rijksuniversiteit Groningen
op gezag van de
rector magnificus prof. dr. E. Sterken
en volgens besluit van het College voor Promoties.

De openbare verdediging zal plaatsvinden op

woensdag 25 mei 2016 om 14.30 uur

door

Wobbe Bouma

geboren op 16 mei 1984
te Drachten-Smallingerland

Promotor:

Prof. Dr. M.A. Mariani

Copromotor:

Dr. I.C.C. van der Horst

Beoordelingscommissie:

Prof. Dr. O.R. Alfieri

Prof. Dr. J.G. Grandjean

Prof. Dr. M.P. van den Berg

Paranimfen:

Michiel Kuijpers

Bert Postma

Part of the research described in this thesis was supported by grants from the National Heart, Lung and Blood Institute of the National Institutes of Health, Bethesda, MD, USA (HL103723, HL63954, HL73021), by grant 95103007 from ZonMw, the Netherlands Organization for Health Research and Development, the Hague, the Netherlands, by an investigator-initiated grant from Medtronic, Minneapolis, MN, USA, and by the Groningen University Institute for Drug Exploration (GUIDE).

Additional financial support for the publication of this thesis is gratefully acknowledged and was provided by: Edwards Lifesciences Netherlands BV, Hans Huysmans Foundation, Krijnen Medical BV, Maquet Netherlands BV, St. Jude Medical Netherlands BV, Sorin Group Netherlands BV, University of Groningen, Vascutek Netherlands BV.

Foar Pake Atte



18-04-1922 – 30-08-2011

Abbreviations

2D	Two-dimensional
3D	Three-dimensional
A	Atrium
A	Apposition
AA	Anterior mitral annulus
Ab	Antibodies
AC	Anterior commissure
AC	Antegrade cardioplegia
AC	Arterial cannula
ACC	Aortic cross-clamp
ACC	American College of Cardiology
ACE(i)	Angiotensin-converting enzyme (inhibitors)
AD	Annular diameter
AHA	American Heart Association
AIMR	Acute ischemic mitral regurgitation
AL	Anterolateral (mitral annulus)
ALPM	Anterolateral papillary muscle
ALPMI	Anterolateral papillary muscle infarction
ALPMR	Anterolateral papillary muscle rupture
(A)MI	(Acute) myocardial infarction
AM(V)L	Anterior mitral valve leaflet
Ao	Aorta
AoC	Aortic cannula
AoV	Aortic valve
aPLs	Antiphospholipid antibodies
APS	antiphospholipid syndrome
APTAR	Anterior / posterior tethering angle ratio
(AP)4CH	(Apical) four-chamber view
ARN	Aortic root needle
ATA	Anterior tethering angle
AUC	Area under the curve
AV	Atrioventricular
AVC	Atrioventricular canal
AVN	Atrioventricular node
BC	Bulbus cordis
BZ	Basal zone
CA	Camera access
CABG	Coronary artery bypass grafting

CAD	Coronary artery disease
CE	Carpentier-Edwards
CHF	Congestive heart failure
CI	Confidence interval
CIMR	Chronic ischemic mitral regurgitation
CK(-MB)	Creatine phosphokinase (myocardial band)
C(L)	Coaptation (line)
CMA	Carpentier-McCarthy-Adams
(C)MR(I)	(Cardiac) magnetic resonance (imaging)
CO ₂	Carbon dioxide (line)
Coapt	Coaptation
CPB	Cardiopulmonary bypass
CRP	C-reactive protein
CRT(-D)	Cardiac resynchronization therapy (-defibrillator)
CS	Coronary sinus
CSD	Cardiac support device
CT	Chordae tendinae
CT	Computertomography
CTSNI	Cardiothoracic Surgical Trials Network
CVA	Cerebrovascular accident
CW	Commissural width
CZ	Clear zone
DDD	Dual chamber / dual demand
ds-DNA	Double stranded deoxyribonucleic acid
EACTS	European Association of CardioThoracic Surgery
EC	Endocardial cushion(s)
EF	Ejection fraction
ERO(A)	Effective regurgitant orifice (area)
ES (II)	EuroSCORE (II)
ESC	European Society of Cardiology
ET	Endocardial tubes
F	Female
FDA	Food and Drug Administration
FO	Foramen ovale
FO	Fossa ovalis
FVC	Fibrous valvular continuity
GA	Groin access
GIPS-III	Glycometabolic Intervention as adjunct to Primary percutaneous intervention in ST elevation myocardial infarction-III trial
HOCM	Hypertrophic obstructive cardiomyopathy
HR	Hazard ratio
IABP	Intra-aortic balloon pump

IACUC	Institutional animal care and use committee
IAG	Interatrial groove
ICD	Implantable cardioverter defibrillator
IMR	Ischemic mitral regurgitation
IPMD	Interpapillary muscle distance
IRA	Infarct-related artery
ISHLT	International Society of Heart and Lung Transplantation
IV	Intravenous
IVCC	Inferior vena cava cannula
IVS	Interventricular septum
L	Lateral (mitral annulus)
LA	Left atrium
LAD	Left anterior descending coronary artery
LCC	Left coronary cusp
(L)Cx	(Left) circumflex coronary artery
LFT	Left fibrous trigone
LGE	Late gadolinium-enhanced
(Log) ES	(Logistic) EuroSCORE
LS	Libman-Sacks
LV	Left ventricle (/ ventricular)
LVEDD	Left ventricular end-diastolic diameter
LVEDP	Left ventricular end-diastolic pressure
LVEDV	Left ventricular end-diastolic volume
LVEF	Left ventricular ejection fraction
LVESD	Left ventricular end-systolic diameter
LVESV	Left ventricular end-systolic volume
LVF	Left ventricular function
LVOT	Left ventricular outflow tract
M	Male
M	MitraClip
MAA	Mitral annular area
MI	Myocardial infarction
MIMVS	Minimally invasive mitral valve surgery
MPI	Myocardial performance index
MR	Mitral regurgitation
MS	Mitral stenosis
MT	Minithoracotomy
MTD	Mitral transverse diameter
MV	Mitral valve
MVA	Mitral valve annulus
MVA	Mitral valve annuloplasty
MVA	Mitral valve area

MVO	Mitral valve orifice
MVP	Mitral valve plasty / repair
MVR	Mitral valve replacement
MVTa	Mitral valve tethering area
MVTI	Mitral valve tethering index
MVTv	Mitral valve tethering volume
N	Normal values
n	Number
NA	Not available / applicable
NCC	Non-coronary cusp
NR	Not reported
NS	Not specified
NSTEMI	Non ST-segment elevation myocardial infarction
NBTE	Non-bacterial thrombotic endocarditis
NYHA	New York Heart Association
OR	Odds ratio
PA	Primitive atrium
PA	Posterior (mitral) annulus
PAP	Pulmonary artery pressure
PBV	Percutaneous balloon valvuloplasty
PC	Posterior commissure
PCh	Primary chords / chordae
PCI	Percutaneous coronary intervention
PCWP	Pulmonary capillary wedge pressure
PHT	Primary heart tube
PISA	Proximal isovelocity surface area
(P)LAX	Parasternal long-axis view
PM	Papillary muscle
PMI	Papillary muscle infarction
PMPM	Posteromedian papillary muscle
PMPMI	Posteromedian papillary muscle infarction
PMPMR	Posteromedian papillary muscle rupture
PMR	Papillary muscle rupture
PM(V)L	Posterior mitral valve leaflet
post-MI PMR	Post-myocardial infarction papillary muscle rupture
(PR-)PTFE	(Pledget reinforced) polytetrafluorethylene
PSAX	Parasternal short-axis view
PTA	Posterior tethering angle
PTMA	Percutaneous transvenous mitral annuloplasty
Pts	Patients
PV	Primitive ventricle
PV	Pulmonary valve

RA	Right atrium
RA	Retractor access
RAA	Right atrial appendage
RC	Retrograde cardioplegia
RCA	Right coronary artery
RCC	Right coronary cusp
Ref	Reference
RFT	Right fibrous trigone
RLPV	Right lower pulmonary vein
ROC	Receiver operating characteristic
RUPV	Right upper pulmonary vein
RV	Regurgitant volume
RV	Right ventricle
RZ	Rough zone
S	Septal (mitral annulus)
SA	Subvalvular apparatus
SAM	Systolic anterior motion
SCh	Secondary chords / chordae
SD	Standard deviation
SE	Standard error
SL	Septolateral
SLE	Systemic lupus erythematosus
SP	Septum primum
SSI	Systolic sphericity index
STEMI	ST-segment elevation myocardial infarction
SVCC	Superior vena cava cannula
T	Tumor
TA	Truncus arteriosus
TA	Tenting area / Tethering area
TCh	Tertiary chords / chordae
TEE	Transesophageal echocardiography
TH	Tenting height / Tethering height
TIMI	Thrombolysis in myocardial infarction
TR	Tricuspid regurgitation
TTE	Transthoracic echocardiography
TV	Tricuspid valve
V	Ventricle
V	Vegetation
V	Vent
VC	Vena contracta
VC	Venous cannula
WMSI	Wall motion score index

Contents

Introduction	Mitral Valve Disease and Mitral Valve Surgery: a Historical Perspective and Technical Innovations	17
Introduction	Scope and Aim of the Thesis	99
<i>Part 1 – Chronic Ischemic Mitral Valve Disease</i>		
Chapter 1	Chronic Ischemic Mitral Regurgitation: Current Treatment Results and New Mechanism-Based Surgical Approaches <i>European Journal of Cardio-thoracic Surgery 2010; 37: 170-185</i>	109
Chapter 2	Reply to the Letter to the Editor “Repair of Chronic Ischemic Mitral Regurgitation with Posterior Leaflet Extension” <i>European Journal of Cardio-thoracic Surgery 2010; 38: 510-511</i>	151
Chapter 3	Chronic Ischemic Mitral Regurgitation and Papillary Muscle Infarction Detected by Late Gadolinium-Enhanced Cardiac Magnetic Resonance Imaging in Patients with ST-Segment Elevation Myocardial Infarction <i>Submitted</i>	155
Chapter 4	Preoperative Three-Dimensional Valve Analysis Predicts Recurrent Ischemic Mitral Regurgitation after Mitral Annuloplasty <i>Annals of Thoracic Surgery 2016; 101: 567-575</i>	175
Chapter 5	Saddle-Shaped Annuloplasty Improves Leaflet Coaptation in Repair for Ischemic Mitral Regurgitation <i>Annals of Thoracic Surgery 2015; 100: 1360-1366</i>	193

Part 2 – Acute Ischemic Mitral Valve Disease

Chapter 6	Mitral Valve Repair for Post-Myocardial Infarction Papillary Muscle Rupture <i>European Journal of Cardio-thoracic Surgery 2013; 44: 1063-1069</i>	213
Chapter 7	Predictors of In-Hospital Mortality after Mitral Valve Surgery For Post-Myocardial Infarction Papillary Muscle Rupture <i>Journal of Cardiothoracic Surgery 2014; 19: 171</i>	231
Chapter 8	Long-Term Survival after Mitral Valve Surgery for Post-Myocardial Infarction Papillary Muscle Rupture <i>Journal of Cardiothoracic Surgery 2015; 10: 11</i>	249

Part 3 – Mitral Valve Disease caused by Endocarditis

Chapter 9	Mitral Valve Surgery for Mitral Regurgitation Caused by Libman-Sacks Endocarditis: a Report of Four Cases and a Systematic Review of the Literature <i>Journal of Cardiothoracic Surgery 2010; 5: 13</i>	271
-----------	---	-----

Part 4 – Mitral Valve Disease in Heart Transplant Recipients

Chapter 10	Mitral Valve Repair and Redo Repair for Mitral Regurgitation in a Heart Transplant Recipient <i>Journal of Cardiothoracic Surgery 2012; 7: 100</i>	297
Discussion and Future Perspectives		307
Summary		317
Samenvatting		323
Dankwoord		329
Curriculum Vitae		335
Bibliography		337

