Local Drug Delivery for Coronary Artery Disease

EDOARDO CAMENZIND MD
Division of Cardiology
University Hospital of Geneva
Geneva, Switzerland

IVAN K DE SCHEERDER
Katholieke Universiteit Leuven
Campus Gasthuisberg
Leuven, Belgium
## Contents

List of contributors ................................................................. vii
Preface ....................................................................................... xiv

### I General introduction

1. The purpose of site-specific therapy  
   Cezar Staniloae, Richard Gallo and Juan J Badimon ........... 1
2. Local drug delivery: impact of pressure, substance characteristics, and stenting on drug transfer into the arterial wall  
   Martin Oberhoff, Andreas Baumbach and Karl R Karsch ........ 7

### II Syllabus of local vascular treatment for coronary artery disease

3. Catheter-based and stent-based treatment for coronary artery disease  
   James Spratt and Edoardo Camenzind .................................. 11

#### Catheter-based delivery

4. The ClearWay™ microporous balloon catheter  
   Geoffrey Moodie, Steve Grantz and Paul Martakos .......... 41
5. The Dispatch® coronary infusion catheter  
   Wendy Naimark arid James Barry .................................. 47
6. The Remedy™ PTCA dilatation infusion catheter  
   Wendy Naimark and James Barry .................................. 53
7. The Infiltrator™ angioplasty balloon catheter  
   Alexander Popov, Herbert Radisch and Peter Barath .......... 59
8. The Infiltrator™ local drug delivery catheter  
   Peter Sinnaeve and Stefan Janssens ............................ 63
9. The needle catheter  
   Sigrid Nikol, Berthold Hofling, Juan Granada, Klaus Pels and Tanya YHuehns .................................................. 67

#### Stent-based delivery

10. Stent-mediated local drug delivery  
    Yanming Huang and Ivan K De Scheerder ...................... 79

### III Inert and non-eluting coatings

11. Silicon carbide-coated stents  
    Bernd Heublein' .......................................................... 99
12. Carbostent: a Carbofilm™-coated stent  
    Antonio L Bartorelli ............................................... 107
13. The PC-coated BiodivYsio™ stent  
    Andrew Lewis and Julian Gunn ................................. 115
14. PTFE-covered stents  
    Richard Heuser .......................................................... 121

### IV Drug eluting coatings

15. Overview of drug delivery coatings  
    Michael Kuehler and B. BRAUN MELSUNGEN AG... 127
16. Phosphorylcholine (PC Technology™) coated stents as a drug delivery platform
   
   Ivan K De Scheerder, Andrew Lewis and Anthony Collias


18. Radioactive stents Christoph Hehrlein

V Syllabus of therapeutic agents

19. Overview of potential drugs to inhibit in-stent restenosis Ivan K De Scheerder

Therapeutic agents

20. Direct antithrombins Vincenzo Toschi

21. Tissue factor inhibitors Maddalena Lettino, Vincenzo Toschi and Juan Jose Badimon

22. Nitric oxide-related interventions and restenosis Hidde Bult, Koen Salu and Guido RY De Meyer

23. Vitamin E and its multiple properties: anti, pro, and non-oxidative activities XianShun Liu and Ivan K De Scheerder


25. Antiinflammatory approaches to restenosis Ivan K De Scheerder and Yanming Huang

26. The role of matrix metalloproteinase inhibitors after arterial injury Amit Segev, Marion J Sierevogel, Gerard Pasterkamp and Bradley H Strauss

27. Methotrexate: a potential drug for stent-mediated local drug delivery: antiinflammatory and antiproliferative characteristics Xianshun Liu and Ivan De Scheerder


29. Local delivery of antisense oligomers to c-myc for the prevention of restenosis Michael JB Kutryk and Patrick W Serruys

VI Pre-clinical studies

Catheter-based intravascular delivery

30. Site-specific delivery of cytostatic agents Martin Oberhoff, Christian Herdeg and Karl RKarsch

31. Catheter-based delivery of NOS gene Stefan Janssens

Inert stents and stent-based intravascular delivery

32. Carbon-coated stents: diamond-like stent coatings Ivan K De Scheerder and Yanming Huang

33. Long-term biocompatibility evaluation of poly-bis-trifluorethoxyphosphazene (PTFEP): a novel biodegradable polymer stent coating in a porcine coronary stent model Yanming Huang, Xiaoshun Liu, Lan Wang, Shengqiao Li, Eric Verbeken and Ivan K De Scheerder
34. Biocompatibility evaluation of biosoluble stent coatings in a porcine coronary stent model
   Shengqiao Li, Yanming Huang, Lan Wang, Eric Verbeken and Ivan K De Scheerder, 307

35. Glycoprotein (GP) IIb/IIIa receptor antagonist eluting stents
   Neil Swanson and Anthony Gershlick, 311

36. Activated protein C eluting stents
   Neil Swanson, Roger Foo and Anthony Gershlick, 315

37. Local methylprednisolone delivery using a BiodivYsio phosphorylcholine (PC)-coated drug delivery stents reduces inflammation and neointimal hyperplasia in a porcine coronary stent model
   Yanming Huang, Xiaoshun Liu, Lan Wang, Eric Verbeken, Shengqiao Li and Ivan K De Scheerder, 317

38. Methotrexate loaded BOBSC-coated coronary stents reduce neointimal hyperplasia in a porcine coronary model
   Yanming Huang, Koen Salu, Xiaoshun Liu, Shengqiao Li, Lan Wang, Eric Verbeken, Johan Bosmans and Ivan K De Scheerder, 325

39. Rapamycin eluting stents
   Robert L Wilensky and Bruce D Klugherz, 337

40. Preclinical evaluation of tacrolimus-coated coronary stents
   Yanming Huang, Shengqiao Li, Lan Wang, Eric Verbeken and Ivan K De Scheerder, 343

41. Local delivery of paclitaxel as a stent coating
   Alan W Heldman, 355

42. Addition of cytochalasin D to a biodegradable oil stent coating inhibits intimal hyperplasia in a porcine coronary model
   Koen J Salu, Yanming Huang, Johan M Bosmans, Xiaoshun Liu, Shengqiao Li, Lan Wang, Eric Verbeken, Hidde Bult, Chris J Vrints and Ivan K De Scheerder, 363

43. Vascular endothelial growth factor (VEGF) eluting stents
   Neil Swanson and Anthony Gershlick, 377

44. An advanced antisense for local and stent based delivery for prevention of restenosis
   Nicholas Kipshidze, Jeffrey W Moses, Patrick Iversen, Patrick W Serruys and Martin B Leon, 381

45. Stent-based gene delivery
   Bruce D Klugherz, Robert J Levy and Robert L Wilensky, 393

VII Clinical studies

Catheter-based intravascular delivery

46. Catheter-based local heparin delivery
   Aaron V Kaplan and Antonio L Bartorelli, 397

47. Local delivery of low molecular weight heparins
   R Stefan Kiesz, M Marius Rozek and Jack L Martin, 405

48. Local delivery of steroids before coronary stent implantation
   Bernhard Reimers and Antonio Colombo, 411

Inert coatings and stent-based intravascular delivery

49. Clinical studies with the Carbostent
   Antonio L Bartorelli and Daniela Trabattoni, 427

50. Gold-coated stents
   Jorg Rodermann and Nicolaus Reifart, 433

51. Heparin-coated stent trials
   Sjoerd H Hofma, Patrick W Serruys and Willem J van der Giessen, 435
vi CONTENTS

52. The Blue Medical 50% TEMPO coronary stent: preclinical studies and the first clinical pilot trial Xiaoshun Liu, Yanming Huang and Ivan De Scheerder
443

53. Dexamethasone: mode of action, preclinical, and clinical studies Ivan K De Scheerder, Xiaoshun Liu, Yanming Huang and Eric Verbeken
457

54. 17β-Estradiol-eluting stents: a potential therapy in the prevention of restenosis Gishel New, Nicholas Kipshidze, Alexander S Abizaid and Antonio Colombo
471

55. Batimastat: mode of action, preclinical, and clinical studies Ivan K De Scheerder, Xiaoshun Liu, Bernard Chevalier, Guy LeClerc and Anthony Collias
483

56. The FIM trial: sirilimus eluting stents Alexandre S Abizaid, Mariano Albertal and Eduardo Sousa
499

57. Tacrolimus eluting stents Eberhard Grube
503

58. Everolimus eluting stents Eberhard Grube and Lutz Buellesfeld
507

59. The Quanam drug eluting stent and the SCORE trial Eberhard Grube
515

60. The Boston Scientific paclitaxel eluting stent: TAXUS I and II Eberhard Grube
523

61. Clinical results with non-polymer based taxol eluting stents. The European evaluation of pacliTaxel Eluting Stent (ELUTES) trial Ivan K De Scheerder, Bernard Chevalier, Edoardo Camenzind and Anthony Gershlick, on behalf of the ELUTES investigators
535

VIII Alternative methods for local vascular drug delivery

62. Intrapericardial drug delivery for prevention of restenosis Dongming Hou and Keith L March
549

63. Alternatives to drug eluting stents: safety and efficacy of systemic delivery of antiproliferative therapy to reduce in-stent neointimal hyperplasia Frank D Kolodgie, Andrew Farb, Herman K Gold, Alok V Finn and Renu Virmani
559

IX Local drug delivery: a critical perspective

64. Drug eluting stents: a critical perspective Renu Virmani, Andrew Farb and Frank D Kolodgie
573

Index
583