

Pathology of Heart Disease in the Fetus, Infant and Child





Pathology of Heart Disease in the Fetus, Infant and Child

Autopsy, Surgical and Molecular Pathology

Michael T. Ashworth

Great Ormond Street Hospital for Children





CAMBRIDGEUNIVERSITY PRESS

University Printing House, Cambridge CB2 8BS, United Kingdom

One Liberty Plaza, 20th Floor, New York, NY 10006, USA

477 Williamstown Road, Port Melbourne, VIC 3207, Australia

314–321, 3rd Floor, Plot 3, Splendor Forum, Jasola District Centre, New Delhi-110025, India

79 Anson Road, #06–04/06, Singapore 079906

Cambridge University Press is part of the University of Cambridge.

It furthers the University's mission by disseminating knowledge in the pursuit of education, learning, and research at the highest international levels of excellence.

www.cambridge.org

Information on this title: www.cambridge.org/9781107116283 DOI: 10.1017/9781316337073

2011 1011017,757,01010007,070

© Michael T. Ashworth 2019

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press.

First published 2019

Printed in Singapore by Markono Print Media Pte Ltd.

A catalogue record for this publication is available from the British Library.

Library of Congress Cataloging-in-Publication Data

Names: Ashworth, Michael T., 1956– author.

Title: Pathology of heart disease in the fetus, infant and child: autopsy, surgical and molecular pathology / Michael T. Ashworth.

Description: Cambridge, United Kingdom; New York, NY, USA: Cambridge University Press, 2019. | Includes bibliographical references and index. Identifiers: LCCN 2019005631 | ISBN 9781107116283 (hardback) Subjects: | MESH: Heart Diseases—pathology | Infant | Fetus | Child | Case Reports Classification: LCC RJ421 | NLM WS 295 | DDC 618.92/12–dc23 LC record available at https://lccn.loc.gov/2019005631

ISBN 978-1-107-11628-3 Hardback

Cambridge University Press has no responsibility for the persistence or accuracy of URLs for external or third-party internet websites referred to in this publication and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.

.....

Every effort has been made in preparing this book to provide accurate and up-to-date information that is in accord with accepted standards and practice at the time of publication. Although case histories are drawn from actual cases, every effort has been made to disguise the identities of the individuals involved. Nevertheless, the authors, editors, and publishers can make no warranties that the information contained herein is totally free from error, not least because clinical standards are constantly changing through research and regulation. The authors, editors, and publishers therefore disclaim all liability for direct or consequential damages resulting from the use of material contained in this book. Readers are strongly advised to pay careful attention to information provided by the manufacturer of any drugs or equipment that they plan to use.



For my sister, Anne.





Contents

	Preface xi		
1	The Anatomy of the Normal Heart 1 1.1 Introduction 1 1.2 Anatomy 1		4.10 Transposition of the Great Arteries 1004.11 Common Arterial Trunk (Truncus Arteriosus) 109
	1.3 Histology 18	5	Congenital Heart Disease (II) 118
	1.4 Electron Microscopy 25		5.1 Double Inlet Ventricle 118
	1.5 Weights and Measures 28		5.2 Double Outlet Ventricle 120
2	Examination of the Heart 33		5.3 Abnormalities of the Pulmonary Veins 121
_	2.1 Introduction 33		5.4 Ebstein's Malformation 124
	2.2 Dissection 33		5.5 Tricuspid Atresia 125
	2.3 Sequential Segmental Analysis 36		5.6 Other Abnormalities of the Tricuspid Valve 120
	2.4 Simulated Echocardiographic Views 40		5.7 Uhl's Anomaly 127
	2.5 Histology 40		5.8 Atrial Isomerism 128
	2.6 Photography 50		5.9 Structural Abnormalities of the Coronary
			Arteries 131
3	Development of the Heart 53		5.10 Other Abnormalities 131
	3.1 Introduction 53		5.11 Anomalies of the Venous Duct (Ductus
	3.2 Brief Recap of Relevant Early Human Embryonic		Venosus) 134
	Development 53		5.12 Pulmonary Vascular Disease in Congenital
	3.3 Brief Summary of Heart Development 54		Heart Disease 138
	3.4 Early Development 54		5.13 Surgical Operations for Congenital Heart Disease 145
	3.5 Looping of the Heart Tube 57		
	3.6 Development of the Chambers and		5.14 Assessment of the Operated Heart 150
	Septation 58 3.7 Pericardium 66	6	Ischaemia and Infarction 155
	3.8 Coronary Arteries 66		6.1 Introduction 155
	3.9 Conduction Tissue 66		6.2 Macroscopic Appearance 155
	3.10 Arterial System 66		6.3 Microscopic Appearance 158
	3.11 Venous System 68		Cardiomyopathy 164
	3.12 The Fetal Circulation and Changes at Birth 70		7.1 Introduction 164
	_		7.2 Hypertrophic Cardiomyopathy 164
4	Congenital Heart Disease (I) 75		7.3 Other Cardiomyopathies with a Hypertrophic
	4.1 Introduction 75		Phenotype 168
	4.2 Ventricular Septal Defect (VSD) 75		7.4 Dilated Cardiomyopathy 170
	4.3 Atrioventricular Septal Defect (AVSD) 78		7.5 Restrictive Cardiomyopathy 173
	4.4 Atrial Septal Defect (ASD) 82		7.6 Eosinophilic Endomyocardial Disease 175
	4.5 Abnormalities of the Arterial Duct 83		7.7 Mitochondrial Cardiomyopathy 176
	4.6 Coarctation of the Aorta 86		7.8 Arrhythmogenic Cardiomyopathy 177
	4.7 Pulmonary Stenosis and Atresia, Including		7.9 Non-Compaction of the Ventricular
	Tetralogy of Fallot 86		Myocardium 179
	4.8 Aortic Stenosis 92		7.10 Histiocytoid Cardiomyopathy 181
	4.9 Hypoplastic Left Heart 96		7 11 Other Forms of Cardiomyonathy 182

7.11 Other Forms of Cardiomyopathy 182



Table of Contents

8		nmation of the Myocardium, Endocardium	12	Fetal (Cardiovascular Disease 252
		orta 187			Introduction 252
	8.1	Introduction 187			The Normal Fetal Heart 252
	8.2	Myocarditis 187			Fetal Hydrops 253
	8.3	Systemic Inflammatory Diseases with Heart			Syndromes with Heart Malformations 255
		Involvement 194			Structural Heart Disease in the Fetus 262
	8.4	Aortitis 197			Fetal Cardiomyopathy 262
	8.5	Endocarditis 199			Fetal Myocarditis 263
9	The C	oronary Arteries 203			Fetal Arrhythmia 266
	9.1	Introduction 203			Fetal Tumours 272
	9.2	Normal Structure 203			Twin–Twin Transfusion Syndrome 274
	9.3	Common Normal Variants of the Coronary		12.11	Conjoined Twins 274
		Arteries 203	13	Tumo	urs 283
	9.4	Abnormal Variations in the Epicardial		13.1	Introduction 283
		Distribution of the Coronary Arteries in the		13.2	Rhabdomyoma 283
		Normally Formed Heart 206		13.3	Fibroma 284
	9.5	Coronary Artery Fistula 206		13.4	Teratoma 285
	9.6	Coronary Artery Hypoplasia and Atresia 209		13.5	Myxoma 287
	9.7	Variations in the Epicardial Coronary Arteries			Vascular Tumours 288
		in Congenital Heart Disease 209		13.7	Cystic Tumour of the
	9.8	Vasculitis Including Kawasaki Disease 211			Atrioventricular Node 289
	9.9	Eosinophilic Granulomatosis with Polyangiitis		13.8	Inflammatory Myofibroblastic Tumour 289
		(Formerly Churg–Strauss Syndrome) 214			Juvenile Xanthogranuloma 290
	9.10	Thrombosis and Embolism 215		13.10	Histiocytoid Cardiomyopathy 292
	9.11	Fibromuscular Dysplasia 216			Lipoma and Other Fatty Lesions 292
	9.12	Segmental Arterial Mediolysis 217			Primary Malignant Tumours 293
	9.13	Idiopathic Arterial Calcification 217			Secondary Tumours 294
10	Metal	polic and Storage Disease 221			Pseudoneoplasms 294
	10.1	Introduction 221	1 /	Hoort	Transplantation 300
	10.2	Glycogen Storage Disorders 221	14		Introduction 300
	10.3	Lysosomal Storage Disorders 227			
	10.4	Mucopolysaccharidosis 229			Assessment of the Explanted Heart 300 The Pathology of the Implanted Heart 311
	10.5	Disorders of Fatty Acid Metabolism 230			Post-Transplant Endomyocardial
	10.6	Congenital Disorders of Glycosylation 235		14.4	Biopsy 313
	10.7	Disorders of Iron Metabolism 236		1/15	Allograft Rejection and Graft Dysfunction
	10.8	Organic Acidaemias and Disorders of Amino		14.5	(Both Acute and Chronic) 313
		Acid Metabolism 237		14.6	Specimen Handling 314
11	Dorica	ardium 243			Artefacts and Variants of Normal 314
11	11.1	Introduction 243			Acute Cellular Rejection 314
	11.2	Congenital Defects of the Pericardium 243			Antibody-Mediated Rejection 317
	11.3	_			Post-Transplant Lymphoproliferative
	11.4	Heterotopia 244		0	Disorder 319
	11.5	Effusions and Tamponade 244		14.11	Post-Transplant Infection of the
	11.6	Epicardial Haemorrhage 245			Myocardium 319
				14.12	Chronic Allograft Vasculopathy 320
	11.7	Haemopericardium 245			Recurrent Disease in the Transplanted
	11.8	Pneumopericardium 245			Heart 321
		Pericarditis 246 Post pericardiotomy Syndrome 240		14.14	Failure of the Cardiac Graft and Its Removal at a
		Post-pericardiotomy Syndrome 249 Constrictive Pericarditis 249			Second Transplant Operation 322
				14.15	Post-Mortem in the Transplanted Heart 322
	11.12	Pericardial Tumours 249			•



15.9 Heart Rhythm Disorders 337

Table of Contents

15	Sudde	en Cardiac Death in the Young 327	15.10 Sudden Infant Death Syndrome 337
	15.1	Introduction 327	15.11 Tumours 339
	15.2	Investigation 327	15.12 Commotio Cordis 339
	15.3	Congenital Heart Disease 327	15.13 Other Rare Causes of Sudden Cardiac
	15.4	Coronary Artery Origin Abnormalities 329	Death 339
	15.5	Cardiomyopathy 330	
	15.6	Aortic Dissection 333	
	15.7	Myocarditis 333	
	15.8	Metabolic Disease 334	Index 342





Preface

There are many books that deal with the pathology of congenital heart disease. Many books treat the pathology of noncongenital heart disease, but few do so from a paediatric perspective. I have read many of them and used them extensively over the years, but there is no single source where one can turn when faced with problems in the interpretation of the pathology of heart disease in the fetus and child. This book is an attempt to address this and to offer, primarily to the practising pathologist, a guide to the pathology of these disorders.

There has been an explosion of knowledge about heart disease since I began medical practice. Newer imaging methods have revolutionized its understanding. The pathology that I practised as a young consultant is no longer practicable. Soon, I suspect, most investigation of congenital heart disease, in death as in life, will be by means of imaging. The traditional cardiac pathologist will no longer practise in the fashion he or she once did. We belong to a profession whose horizons are changing, but before they do, I wish to make available the wealth of cases that I have seen over the years and the likes of which may not be seen in quite the same way again, but which are still valuable in understanding childhood heart disease.

I wish to express my thanks to the people who have helped this book come about. Firstly to Dr Jean Keeling who many years ago suggested I write a monograph on cardiac pathology, and to my late lamented colleague Dr Marian Malone at whose suggestion I began this particular work four years ago and who put me in touch with Cambridge University Press. My thanks to Professor Jem Berry who first encouraged me in paediatric cardiac pathology, and to Dr Audrey Smith who guided my first steps on that road. To my current Consultant colleagues at Great Ormond St Hospital, Neil Sebire, Liina Palm, Sam Levine and Thivya Sekar who have indulged my interest, and to my many pathology colleagues in the United Kingdom and abroad who have generously referred me cases over the years that have increased my understanding, even if I have not always increased theirs, I am grateful. To my clinical colleagues too numerous to list by name in cardiac surgery, cardiology and radiology in Bristol, Liverpool and London who have given of their time and experience, my heartfelt thanks.

Finally, in completing this work I can do no better than echo the words of the unknown ancient author of 2 Maccabees:

If it is well told and to the point, that is what I myself desired: if it is poorly done and mediocre, that was the best I could do.

(2 Mac 15:38)

