

Fractures of the Scapula

Current Management Concepts

Robinson Esteves Pires

Pedro José Labronici

Vincenzo Giordano



Springer

Fractures of the Scapula

Robinson Esteves Pires • Pedro José Labronici
Vincenzo Giordano
Editors

Fractures of the Scapula

Current Management Concepts

 Springer

Editors

Robinson Esteves Pires
Department of the Locomotor Apparatus
Federal University of Minas Gerais
Belo Horizonte, Minas Gerais, Brazil

Pedro José Labronici
Department of General and
Specialized Surgery
Fluminense Federal University
Niterói, Brazil

Vincenzo Giordano
Orthopedics Department
Hospital Municipal Miguel Couto
Rio de Janeiro, Brazil

ISBN 978-3-031-58497-8 ISBN 978-3-031-58498-5 (eBook)
<https://doi.org/10.1007/978-3-031-58498-5>

© The Editor(s) (if applicable) and The Author(s), under exclusive license to Springer Nature Switzerland AG 2024

This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

If disposing of this product, please recycle the paper.

Foreword

It is an honor to write a foreword for this important book on scapula fractures. The amount of information has exploded in the last two decades to improve diagnosis, management, approaches and outcomes of severe scapular fractures, and shoulder girdle injuries. As a resident, I saw only one formal Judet approach to the scapula with master surgeons, Steven Benirschke and Keith Mayo. These are relatively rare injuries and surgical indications were few at the time. As a young faculty, I approached my first severely comminuted, displaced scapula neck and body fracture with the formal Judet approach and thought that there must be a better way that is less invasive. This was in the early years of minimally invasive osteosynthesis and we described the modified Judet approach which I used for years, but others modified this modification to identify that the deltoid rarely needs to be released and that many fractures can be treated with even less invasive approaches. It also was noted that the reduction usually was to medialize the body and not to lateralize the glenoid. Further imaging studies confirmed that the glenoid remains in place as long as it is connected to the shoulder girdle and the scapula body lateralizes due to the pull of the posterior scapular muscles. This book reviews the increased knowledge of the last 20 years of scapula fracture diagnosis, approaches, and fixation strategies. We still have much to learn, but I believe these chapters increase our knowledge and understanding and guide us to improved outcomes for patients.

Nashville, TN, USA

William Obrebsky

Foreword

In the craft of surgery the master word is simplicity
—Berkeley George Andrew Moynihan (1865–1936)

It is an honor to introduce this well-written textbook. My good friends *Robinson E. Pires, Pedro J. Labronici, and Vincenzo Giordano*, superb Brazilian surgeons and educators, have worked closely with a first-class group of international contributors to deliver this book written in a comprehensive way dedicated to the ones involved with reconstruction of the scapula region. The publication is updated and reviews all the important aspects—from basic science to complex reconstruction—of this intricate and singular anatomic area.

Osteosynthesis was one of the greatest advances in orthopedic surgery—together with and arthroplasty and arthroscopy—of the twentieth century. The advances in this field take place every day around the globe and a textbook like this brings us the well-established principles and concepts.

From the nonoperative management to the still not well-recognized floating flail chest, the authors bring their own way of performing procedures to the benefit of the patients.

I congratulate the authors for this worthwhile addition to the trauma and shoulder surgery literature.

Passo Fundo, Brazil
April 2024

Osvandre Lech

Preface

The idea of this book stemmed from the collective expertise of three orthopaedic trauma surgeons deeply passionate about this subject. In recent decades, we have devoted a substantial portion of our professional careers to providing care for patients affected by this uncommon but challenging fracture.

Fractures of the Scapula: Current Management Concepts serves as a comprehensive guide for orthopaedic trauma surgeons, shoulder surgeons, thoracic surgeons, orthopaedic fellows and residents, medical students, physical therapists, and medical professionals involved in the care of patients with scapular fractures either isolated or associated with other injuries. This book aims to provide an in-depth exploration of the latest management strategies, surgical techniques, and rehabilitation protocols for these complex injuries.

In this book, renowned experts in the field from all over the globe share their insights and experiences, offering practical advice and evidence-based recommendations to navigate the diagnosis and treatment of scapular fractures effectively. Chapters cover a wide range of topics, including anatomy, embryology, classification systems, imaging, non-operative management, surgical indications, traditional and minimally invasive approaches, reduction and fixation strategies, rehabilitation protocols, and complications. The book will also delve into the concept of the floating shoulder and tackle a pertinent and emerging issue: periprosthetic scapular fractures subsequent to reverse shoulder arthroplasty.

As the understanding of scapular fractures continues to evolve, it is essential for healthcare providers to stay abreast of the latest advancements in the field. This book serves as a valuable resource, combining theoretical knowledge with practical guidance to enhance the care of patients with fractures of the scapula.

We hope that *Fractures of the Scapula: Current Management Concepts* will serve as a trusted companion for professionals involved with the care of patients sustaining scapular fractures, seeking to optimize their outcomes and improve their quality of life.

Belo Horizonte, Brazil
Niterói, Brazil
Rio de Janeiro, Brazil

Robinson Esteves Pires
Pedro José Labronici
Vincenzo Giordano

Acknowledgements

Acknowledgement by Vincenzo Giordano I dedicate this book first and foremost to my wife Érika and my daughters Carolina and Fernanda, whom I love deeply and who drive me every day to be a better person, professional, friend and, of course, husband and father. I also dedicate it to my parents José and Lúcia, brother Marcos, and aunt Sônia, who have always supported me in my professional decisions and helped me to remain firm in these choices. Finally, I dedicate it to my colleagues and friends at the Serviço de Ortopedia e Traumatologia Prof. Nova Monteiro–Hospital Municipal Miguel Couto, who have supported me for the last 30 years, and to the friends that orthopaedics has given me in life, including my two partners in this book, Robinson and Pedro, brothers in life.

Acknowledgement by Robinson Esteves Pires I would like to extend my appreciation to all the contributors who dedicated their time, expertise, and passion to make this book possible. Your invaluable insights and contributions have enriched the content and elevated the quality of this publication.

I am deeply thankful to the editorial team (Erica Ferraz, Anila Vijayan, and Jananee Ravichandran) for their dedication, professionalism, and tireless efforts throughout the entire process. Your attention to detail and commitment to excellence have been instrumental in shaping this book into its final form.

I am also grateful to my partners and special friends Vincenzo Giordano and Pedro Labronici for their commitment, engagement, assistance, expertise, and cooperation in all aspects of this project.

I would like to express my deepest gratitude to my mentors Prof. Márcio Ibrahim de Carvalho (*in Memoriam*), Prof. Fernando Baldy dos Reis, Prof. Marco Antônio Percope de Andrade, and Dr. Antônio Eleuterio Costa Pires, whose guidance, wisdom, and support have been instrumental in shaping my career and professional development.

I would also like to extend my thanks to the fellows, residents, and my partners in the orthopaedic surgery team at Felício Rocho Hospital, Orizonti Institute, and Risoleta Tolentino Neves Hospital, as well as to our patients, for making this dream possible.

Lastly, I want to express my heartfelt gratitude to my wife Ludmila and my daughters Laura and Gabriela for their unconditional support, patience, and encouragement during this long journey. I also would like to dedicate this book to my parents Helenice (*in Memoriam*) and Geraldo, as well as my brothers, Rodrigo and Robledo. Your unwavering support and guidance have been fundamental to my personal and professional development. I really hope that both patients and surgeons will benefit from the knowledge conveyed in this book.

Acknowledgement by Pedro José Labronici This is a very special moment for me, in which I express my deep gratitude, affection, and recognition to extraordinary individuals who played significant roles in my journey, especially for my two brothers at heart, Robinson Esteves and Vincenzo Giordano. Firstly, I dedicate this book to the surgeons passionate about the complexities of scapula fractures, a challenging and intricately treated injury.

Equally important, I dedicate this work to my beloved wife, Rosa, and my children, Ana Carolina, Gustavo, and Rodrigo. With their affection and unwavering support, they have been fundamental pillars that propelled me through this crucial phase of my life.

I also express my gratitude to my colleagues, whose constant support has been vital in my professional journey. To Hospital Santa Teresa (Congregação Santa Catarina) in Petrópolis, where I had the opportunity to enhance my professional knowledge, I extend my special acknowledgement.

Last but not least, I pay tribute “in memoriam” to my father, Aldo Labronici, who, besides being an orthopaedist, was my guide and mentor. I also dedicate this work to Donato D’angelo, who believed in my medical potential and imparted valuable lessons along the way. Their influences were crucial to my journey, and I am eternally grateful for their trust and guidance.

Contents

1	Embryology, Anatomy, Biomechanics, Injury Mechanism, and Epidemiology of Scapular Fractures	1
	Robinson Esteves Pires, Pedro José Labronici, and Vincenzo Giordano	
2	Classification Systems for Scapular Fractures: How Useful Are They?	9
	Robinson Esteves Pires, Pedro José Labronici, and Vincenzo Giordano	
3	Non-operative Management of Scapular Fractures: Patient Selection, Treatment Protocol, and Expected Outcomes	21
	Robinson Esteves Pires, Pedro José Labronici, and Vincenzo Giordano	
4	Scapular Fractures in Children and Adolescents	27
	Robinson Esteves Pires, Pedro José Labronici, and Vincenzo Giordano	
5	Approaches and Fixation Strategies for Scapular Fractures (Pitfalls and Opportunities): MIO Versus Conventional ORIF	33
	Nathaniel E. Schaffer, Jaclyn M. Kapilow, and William T. Obremskey	
6	Special Considerations: Fractures of the Scapular Neck and Body	45
	Kyle Auger, Jaclyn M. Jankowski, Richard S. Yoon, and Robinson Esteves Pires	
7	Special Considerations: Articular Involvement (Glenoid Fossa and Rim)	57
	Vincenzo Giordano, David Rojas, and Robinson Esteves Pires	

8 Special Considerations: Fractures of the Coracoid Process and Acromion 73
Pedro José Labronici, Robinson Esteves Pires, and Vincenzo Giordano

9 Special Considerations: The Floating Shoulder—Myths and Reality 89
Fabio A. Suarez Romero and Federico Suarez Rodriguez

10 Special Considerations: The Floating Flail Chest—A New Entity . . . 101
Robinson Esteves Pires, Vincenzo Giordano, and Pedro José Labronici

11 Special Considerations: Complex Scapular Fractures—Preoperative Planning and Fixation Strategies (Case Based) 111
Vincenzo Giordano, Robinson Esteves Pires, and Pedro José Labronici

12 Periprosthetic Scapular Fractures Following Reverse Shoulder Arthroplasty 129
Robinson Esteves Pires, Parag Shah, Chittaranjan Patel, and Vincenzo Giordano

13 Rehabilitation After Scapular Fractures 137
Andrea Lopes Sauers, Rita Ator, and Jaime González

Index..... 145

About the Editors

Robinson Esteves Pires is a Professor of Orthopaedic Surgery and Traumatology at the Federal University of Minas Gerais, Belo Horizonte (MG), Brazil. Dr. Pires serves as the Chief of the Orthopaedic Trauma Service at Felício Rocho Hospital and Orizonti Institute. With a master's degree from the Federal University of São Paulo, Dr. Pires pursued his PhD and post-doctoral research at the Federal University of Minas Gerais. He completed a fellowship in Orthopaedic Trauma at the Federal University of São Paulo and served as visiting fellow at the University of Colorado (Denver Health Medical Center), University of California San Francisco (Orthopaedic Trauma Institute), and UC Davis (Sacramento, CA, USA). Dr. Pires is also an international AO Trauma Faculty and actively contributes to the Research Support Group of AO Trauma Latin America, while serving as a board member of AO Trauma Brazil. He is currently a member of the AO Trauma Lower Extremity Education Task Force.

Previously, he held the position of President of the Brazilian Society of Orthopedics and Traumatology (Minas Gerais State) and has been elected as President of the Brazilian Society of Orthopaedic Trauma for the year 2025. With a prolific academic career, Dr. Pires has authored several papers published in peer-reviewed journals and contributed to a substantial number of book chapters in the field of orthopaedic trauma.

Pedro José Labronici holds a master's degree in Medicine (Orthopedics and Traumatology) from the Federal University of Rio de Janeiro (UFRJ), a PhD in Orthopedics and Traumatology from the Federal University of São Paulo, Paulista School of Medicine (UNIFESP), and did his post-doctorate at the Fluminense Federal University (UFF). Dr. Labronici is currently Head of the Orthopedics and Traumatology Department at Santa Teresa Hospital. Dr. Labronici is an AO Trauma Faculty, a member of the Shoulder and Elbow Task Force of the AO International Trauma Group, and a board member of the Brazilian Orthopaedic Trauma Society. Dr. Labronici is a Full Professor at the Petrópolis School of Medicine. He is also an Associate Professor at the Universidade Federal Fluminense (UFF) and an Associate Professor at the Universidade Católica de Petrópolis. He also teaches in the post-graduate programme at the Universidade Federal Fluminense.

Vincenzo Giordano is an orthopaedic trauma surgeon and consultant at the Serviço de Ortopedia e Traumatologia Prof. Nova Monteiro—Miguel Couto Municipal Hospital since 1994. He has a master's degree and PhD from the Federal University of Rio de Janeiro and a post-doctorate from the Federal Fluminense University. He did a clinical fellow in orthopaedic trauma in 1999 at the University of Alabama at Birmingham and visiting fellows at the Klinik für Unfallchirurgie of the Medizinische Hochschule Hannover in 2002 and at the Klinik für Traumatologie of the Universitätsspital Zürich in 2005.

Dr. Giordano is currently the Research Officer for the AO Trauma Latin America and an International AO Trauma Faculty. He is fellow of the Brazilian College of Surgeons and responsible for the orthopaedic chapter. He is fellow of the Brazilian Academy of Military Medicine and responsible for the Surgical Clinics Section. He is past chair of the AO Trauma Brazil, the Brazilian Society of Orthopaedic Trauma, and the Brazilian Society of Orthopaedics and Traumatology (Rio de Janeiro State).

Dr. Giordano has several publications and book chapters in the area of orthopaedic trauma, many related to scapula fractures in partnership with the other authors of this book (R.E.S. and P.J.L.).

Chapter 1

Embryology, Anatomy, Biomechanics, Injury Mechanism, and Epidemiology of Scapular Fractures



Robinson Esteves Pires, Pedro José Labronici, and Vincenzo Giordano

1.1 Embryology of the Scapula

The development of the scapula is controlled by different genetic regulation in relation to the rest of the upper extremity. The embryology and genetic origin of the scapula are more similar to the spine, which explains the association between scapular and vertebral anomalies [1]. The knowledge of the embryology of the scapula is of paramount importance, since congenital anomalies, malformation, and abnormal scapular positioning may affect heart and respiratory functions and directly impair the function of the ipsilateral upper extremity [2].

Hita-Contreras et al. [3] reported three outgrowths of the mesenchymal condensation with irregular shape corresponding to the scapular body, the coracoid process, and a large mass of the acromion, scapular spine, and the humerus. However, the authors have not described whether the three outgrowths were connected. The morphogenesis of the coracoid process is different from the scapular body in several aspects. The coracoid ossification begins after the birth, differently from the scapular body. In average, between the 15th and 18th months after birth, ossification occurs in the middle of the coracoid process, which merges with the rest of the bone at 15 years of age [4–6].

R. E. Pires (✉)

Department of the Locomotor Apparatus, Federal University of Minas Gerais, Belo Horizonte, Minas Gerais, Brazil

P. J. Labronici

Department of General and Specialized Surgery, Fluminense Federal University, Niterói, Brazil

V. Giordano

Orthopedics Department, Hospital Municipal Miguel Couto, Rio de Janeiro, Brazil

Müller and O’Rahilly [7] reported that the scapula is enlarged in the embryonic period, but it does not descend. Tanaka et al. [6] supported this finding in a morphometric study. Landmarks on the scapula and clavicle (superior angle, sternoclavicular joint, acromioclavicular joint, and glenoid fossa) remain in similar axial position, while only the axial position of the inferior angle decreases, which indicates that the scapula increases caudally, although it didn’t descend.

1.2 Anatomy

The scapula is attached to the axial skeleton by the clavicle through the acromioclavicular and sternoclavicular joints, forming part of the shoulder girdle. The scapula rests on the posterior chest wall between the second and seventh costal ribs. The trapezius and the elevator scapulae are mainly responsible for holding the scapula in this position.

With an angle of approximately 30° between the scapula and the frontal plane, the scapula is primarily responsible for providing support to the humeral head.

The scapula presents a flat triangular shape divided into parts defined by the superior, medial, and lateral borders. In addition to the scapular spine and medial and lateral pillars, the scapula presents a three-dimensional anatomy which forms the scapular neck and the glenoid fossa. Posteriorly, the division between the scapular body and neck is marked by the spinoglenoid notch. The coracoid process is originated by the anterosuperior surface of the scapular neck. The glenoid fossa is concave and presents a pear-shaped articular surface with a prominent ring of fibrocartilage at its wider end (the glenoid labrum). The scapular spine divides the posterior surface of the scapula into the supra- and infraspinatus fossa. On the lateral aspect, the scapular spine becomes more elevated and ends on the acromion (Fig. 1.1). Knowing the distribution of the bony mass of the scapula is quite important, since implants are frequently applied on the surfaces which present a denser bone. The margins of the glenoid fossa, the scapular neck, and the base of the coracoid process are the regions with the highest bone density. Cancellous bone can be found only in the lateral angle of the scapula. The scapula presents two bony pillars, which cross from the glenoid to the scapular body, and transmit compression forces from the glenoid fossa.

The central zone of the scapula is a flat, extremely thin, and weak area. Most scapular body fractures cross this weak zone. Similarly, the central part of the scapular spine is also a relatively weak area, which justifies the fact of fracture lines generally reach this area [8]. The muscular complex that acts on the scapula should be divided into two main systems (scapuloaxial and scapulobrachial) [8]. The former connects the scapula with the axial skeleton, the spine, and the chest wall, being responsible for moving the scapula over the chest wall, whereas the latter is