

Temporomandibular Joint Total Joint Replacement – TMJ TJR

A Comprehensive Reference
for Researchers, Materials
Scientists, and Surgeons

Louis G. Mercuri *Editor*

Foreword by
Joshua J. Jacobs, M.D.

 Springer

Temporomandibular Joint Total Joint
Replacement – TMJ TJR

Louis G. Mercuri
Editor

Temporomandibular Joint Total Joint Replacement – TMJ TJR

A Comprehensive Reference for Researchers,
Materials Scientists, and Surgeons

Foreword by Joshua J. Jacobs, M.D.

 Springer

Editor

Louis G. Mercuri
Department of Orthopedic Surgery
Rush University Medical Center
Chicago, IL, USA

ISBN 978-3-319-21388-0 ISBN 978-3-319-21389-7 (eBook)
DOI 10.1007/978-3-319-21389-7

Library of Congress Control Number: 2015955824

Springer Cham Heidelberg New York Dordrecht London
© Springer International Publishing Switzerland 2016

This work is subject to copyright. All rights are reserved 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, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Printed on acid-free paper

Springer International Publishing AG Switzerland is part of Springer Science+Business Media
(www.springer.com)

*To my mentors Gustav Kruger,
Daniel Laskin, S. Elmer Bear, and notably
Larry Peterson who cultivated my interest
as a student in oral and maxillofacial
surgery; all the students and residents
who consistently pushed me to look for
answers; and to my research colleagues
who keep me asking “why.”
Most importantly, to my wife Joan, whose
love, encouragement, and understanding
have been a constant source of strength
and determination in my career.*

Foreword

Joint replacement has been one of the great success stories of modern medicine. Lower extremity joint replacement, in particular, has revolutionized the treatment of end-stage diseases involving the hip and knee, and total hip and total knee arthroplasty are among the most commonly performed and successful procedures. In the USA, alone over one million hip and knee replacements are performed on an annual basis. For these large lower extremity joint replacements, survivorships in excess of 90 % at 10 years are typical and will likely be surpassed with improvements in surgical technique, implant materials, and implant design.

While hip and knee arthroplasty are considered to be very reliable and effective procedures, this is not the case for other joints such as the ankle, elbow, and wrist where the anatomical and biomechanical milieu may be more complicated. This is also the case for the temporomandibular joint (TMJ). Although temporomandibular joint disorders are not nearly as common as osteoarthritis of the hip and knee, there is a large patient population that is affected, often leading to considerable disability. In the appropriate patient population, TMJ arthroplasty can be a very effective treatment, and like other joint arthroplasties, restoration of function, maintenance of fixation, and minimization of implant and periprosthetic bone and soft tissue degradation are key in determining the ultimate success of this intervention.

In this volume, the authors have provided a valuable addition to the extant literature by summarizing the state of the art and science in TMJ arthroplasty. There are many scientific advances summarized in this book that are relevant to understanding of the performance of TMJ arthroplasty and also provide a pathway to improve the ultimate outcomes of this intervention. This book is recommended to biomaterials scientists either in training or in practice who are working in the area of TMJ arthroplasty as well as to clinicians either in training or in practice who care for patients with TMJ disorders. Kudos go to the authors for their scholarly contributions to this important topic.

Rush University Medical Center
Department of Orthopedic Surgery
Chicago, IL, USA

Joshua J. Jacobs, M.D.
William A. Hark, M.D./Susanne G. Swift
Professor and Chairman

Preface

The practice of reconstructive orthopedic surgery would be unthinkable and impossible without the availability of alloplastic joint replacement devices. In the 1960s, posed with the problem that resection arthroplasty was an uncertain procedure with recurrent deformity and limited motion as common complications, Sir John Charnley (Fig. 1) developed a successful low-friction total alloplastic joint replacement device. Since that time, with the evolution of surgical techniques, implant materials, and designs, excellent long-term function and quality-of-life improvement results have been reported along with device survival rates exceeding 90 % after 10 years.

Temporomandibular joint (TMJ) reconstruction presents unique problems because of the integral and complex roles the TMJ plays in establishing and maintaining proper form and function within the stomatognathic system. The TMJ not only acts as a secondary growth center for the mandible in prepuberty but also is essential to the functions of mastication, speech, airway support, and deglutition in both child and adulthood.

Alloplastic materials have been employed for decades in the management of primary and secondary TMJ pathology. Prior to the early to mid-1980s, the primary reasons for TMJ reconstruction were the management of developmental maxillofacial deformities, ankylosis, severe inflammatory joint disease, or TMJ replacement after ablative tumor surgery or trauma. Most of these early reports of the use of alloplastic material were single cases with no long-term follow-up; hence, complications were often unreported.

Thereafter, along with these form and function challenges, there arose a group of patients who presented requiring TMJ reconstruction having previously undergone multiple failed TMJ surgical procedures. Many of these patients' TMJs were anatomically distorted and functionless secondary to the failure of interpositional materials such as Proplast—Teflon (Vitek, Houston, TX) and/or silicone rubber (Dow-Corning-Wright, Arlington, TX). Early in the 1990s, it was discovered that failure of these materials had caused wear-related foreign body giant cell reactions resulting in significant end-stage TMJ anatomical architectural changes necessitating total joint replacement (TJR).

As the number of these unfortunate patients grew (an estimated 26,000 Proplast-Teflon containing TMJ devices had been implanted in the USA between its introduction in the early 1980s and 1992), interested reconstructive surgeons began developing goals to reach a physiologically reasonable, biologically rational, and technically achievable TMJ TJR outcome taking into consideration not only TMJ form and function but also these patients' neurological and psychological needs. Utilizing time-tested orthopedic technologic and materials science advances, custom and stock TMJ TJR devices were developed, approved, and manufactured to manage these and future end-stage TMJ disease cases. Furthermore, modern TMJ TJR surgeons also realized that due to the complex nature of joint anatomical and related masticatory muscle functional relationships, it was unreasonable to expect that a reconstructed TMJ could be returned to "normal" premorbid function. There will always be some functional disability involved with any reconstructed TMJ.

In the multiple-operated, anatomically distorted patients, chronic neuropathic centrally mediated pain will be a major component of their disability. Therefore, it is important for both surgeon and patient to understand that the primary goal of any type of TMJ reconstruction is the restoration of objective mandibular form and function. Any subjective pain relief gained must only be considered as of secondary benefit.

Based on evidence from the orthopedic, biomedical engineering, materials science, and oral and maxillofacial surgery literature, and the expertise of the contributing authors, this book discusses the role TMJ TJR can play as a salvage device in the management of patients with severe, debilitating end-stage TMJ anatomical disorders.

The biomechanics and biomaterials chapters present the basics of TMJ biomechanics and the rationale for the biomaterials used in the development and manufacture of modern TMJ TJR devices. A chronological historical review provides readers with information on the successes and failures associated with TMJ alloplastic devices so that, in the future, the successes can be built upon, and the failures avoided.

Fig. 1 Professor Sir John Chamley, FRS. 1911–1982 (Wroblewski BM. Professor Sir John Chamley (1911–1982). Rheumatology. 2002. 41: 824–5



In the following chapters, the clinical indications and contraindications, surgical techniques, and outcomes for custom and stock TMJ TJR devices are presented, together with the diagnosis, avoidance, and management protocols for common TMJ TJR device complications and failure.

In the tribocorrosion chapter, the role of this latest advance in materials science analysis for the study of functional material wear and the peri-articular tissue responses will be discussed. In the following chapter, the complex, controversial, and vexing issue of alloplastic TJR material hypersensitivity will be considered in detail.

Finally, the potential for the development and use of bioengineered tissue in the design and production of viable TMJ TJR replacement devices will be presented and considered.

This text is designed to be the first comprehensive reference of its kind not only for reconstructive surgeons and materials scientists but also for all TMJ researchers as they seek to improve the management of end-stage TMJ disease for patients.

Chicago, IL, USA

Louis G. Mercuri, DDS, MS

Contents

Part I Biomechanics and Biomaterials

- 1 **TMJ Biomechanics**..... 3
Hannah J. Lundberg
- 2 **TMJ TJR Biomaterials**..... 29
Robert E. Baier and Anne E. Meyer
- 3 **History of TMJ TJR** 41
Louis G. Mercuri

Part II TMJ TJR Devices

- 4 **Stock Prosthesis for Total Reconstruction of the Temporomandibular Joint**..... 69
Peter Quinn and Eric J. Granquist
- 5 **Custom TMJ TJR Devices** 91
Louis G. Mercuri

Part III Advanced TMJ TJR Techniques

- 6 **Concomitant TMJ Total Joint Replacement and Orthognathic Surgery** 133
Larry M. Wolford
- 7 **Mandibular Replacement Utilizing TMJ TJR Devices** 165
Luis Vega and Daniel Meara

Part IV Complications

- 8 **Complications Associated with TMJ TJR: Management and Prevention** 187
Louis G. Mercuri
- 9 **Material Hypersensitivity**..... 227
Nadim Hallab

10 Tribocorrosion and TMJ TJR Devices..... 251
Mathew Mathew, Shelley Kerwell, Maria Alfaro,
Dmitry Royman, Valentim Barao, and Sukotjo Cortino

11 Management of Failing and Failed TMJ TJR Devices..... 265
Louis G. Mercuri

Part V Future Considerations

12 Bioengineered Tissue TMJ TJR..... 281
E. Weston Santee, Sharon Aronovich, and Stephen E. Feinberg

Index..... 299