Diseases of the temporomandibular apparatus

A MULTIDISCIPLINARY APPROACH

Editors

MORGAN • HALL • VAMVAS

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A MULTIDISCIPLINARY APPROACH

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To our wives,
whose unfailing support and understanding
of time away from family activities enabled us
to complete this work.

Adrienne Atwood Morgan
Billie Gay Hall
Antonia Vamvas

FOREWORD

The need for awareness and understanding of the many variables presented by disorders of the temporomandibular joint and masticatory apparatus is recognized by all who have been faced with such problems. This book, I believe, will increase our awareness as well as serve as a reference to bring knowledge and understanding to all professionals who may find themselves responsible for diagnosing or treating these disorders.

This book is offered as a result of a team effort spearheaded by the authors. The concepts presented are representative of the clinical research and practices guiding the work of the White Memorial Medical Center TMJ Clinic Conferences and the two-day didactic courses covering this subject sponsored by the TMJ Research Foundation and the White Memorial Otolaryngology Foundation, Inc. It has been compiled to make available useful information from the basic sciences and clinical features of this disorder and to outline methods of management.

As a result of mutual concern regarding a patient many years ago, Dr. Morgan and I have shared a common interest. Recognizing the lack of reference material and texts covering this subject, I am pleased to encourage and support the authors in their efforts. I believe this will be a practical reference and guide to those who are looking for help with these difficult problems.

Leland R. House, M.D.

PREFACE

The area of the temporomandibular joint and the adjacent structures has been a sleeping giant. Dentistry and medicine have long been aware that this is the only joint in the body that has a sliding-gliding action, functioning as a unit because of the mandible's tieing the two condyles together. However, its many other intricacies are just now beginning to be appreciated. Disease and dysfunction of this region affect large numbers of people. It is estimated that over 20% of the average population at one time or another has symptoms relating to the temporomandibular apparatus. In this book, we have decided to use the term *apparatus* rather than *joint,* since the TMJ is but one part of this complicated structure. The joint is the foundation for this study, but the entire structure must be considered.

We owe much to the writings in the early 1930s of Dr. James Costen, the first individual to explain some of the symptoms that can arise in this joint and to come up with recommendations for treatment. Dr. Costen wrote extensively in the medical literature over a period of years, describing what came to be called *Costen's syndrome.* Because some of his early anatomical information was incomplete, in later years some anatomists tended to discredit the work of Dr. Costen as not being anatomically valid. In reviewing Dr. Costen's work, we have found much valuable material that is of use today.

As information became available in regard to the anatomy and function of the joint, we were able to use many diverse modalities in treating this problem. Credit is due Dr. Laszlo Schwartz and, later, his colleague, Dr. Charles Chayes, for their definitive work encompassing the field at that time. Dr. N. A. Shore has added materially to our understanding in this region, particularly by his studies with splint appliances. We are indebted to Dr. Harold Gelb and to Dr. Daniel Laskin, of the TMJ Research Center at the University of Illinois School of Dentistry, who did much to create interest in the dental and medical professions over the last 15 years with regard to this problem. Anatomists, such as Dr. Olympio Pinto of Rio de Janeiro, Brazil, encouraged by Drs. David Goodfriend of Philadelphia and F. Schmidt of Germany, have substantially added to our anatomical understanding of this joint. We are indebted to Drs. William Irby, Robert Walker, Eugene Dyer, Clawson Skinner, Marvin Alderman, Weldon Bell, and C. E. Norris for their research studies and literature contributions. For increased radiographic understanding we are indebted to Drs. William Updegrave, Lawrence Weinberg, and Robert Ricketts. In the field of occlusion we wish to credit Dr. Rex Ingraham, who developed the first Department of Occlusion at the University of Southern California School of Dentistry. We are also indebted to such men directing TMJ clinics as Drs. Sylvan Schireson at the University of Southern California, William Solberg at the University of California at Los Angeles, and Charles McNeil at the University of California at San Francisco. Credit is also due the American Equilibration Society for its *Compendium* and The American Society of Oral Surgeons for its Symposium on TMJ.

Work with the temporomandibular apparatus is most fascinating. It is not limited to the discipline of any one particular field but encompasses in part nearly every specialty within dentistry and medicine. The work of the TMJ, therefore, brings together the dental and medical professions and lays to rest forever the misconception of dental treat-

ment as purely mechanistic and unrelated to the rest of the body. Many of the symptoms related to TMJ dysfunction have been thought of as purely medical; however, much of the treatment to relieve these symptoms will be accomplished by dentists in cooperation with other specialists. Our philosophy expounded in this book is for the team approach. There is a symbiotic relationship between the work of the general dentist, oral-maxillofacial surgeon, orthodontist, ENT specialist, psychologist, neurologist, allergist, physiotherapist, and myofunctional therapist. The team approach benefits not only the patient but the practitioners involved, enabling them to use their own special talents to help the large number of people who are afflicted with this problem.

The material presented in this book has been collected from our files over a period of 15 years and contains current ideas on the subject as well as the concepts of the past. Some of these past concepts we may now find outmoded, but they have, nevertheless, been a part of the ongoing development of this subject and worthy of note. We are at the beginning of the development of a new field relating dentistry and medicine in a manner that will bring about significant benefits to many people. It is possible that in the future there will be dentists and physicians who will spend a great deal of their time specifically helping individuals with TMJ problems. Indeed, a specialty encompassing the dental and medical aspects of this apparatus may evolve.

We believe that this book will be of particular interest to the oral-maxillofacial surgeon, general dentist, orthodontist, and prosthodontist, as well as to the otolaryngologist, radiologist, neurologist, neurosurgeon, and psychiatrist. The team approach is emphasized even though there may be some patients who can be effectively treated by one practitioner using only one modality. However, we find the best results are more often obtained through several treatment modalities, such as gnathology, dental splints, and physiotherapy. In this book, we have endeavored to cover all treatments so as not to omit any beneficial therapy. This book has been divided into four sections: growth and development, diagnosis, treatment, and developing areas.

We are most grateful to those who have assisted us in preparation of the manuscript: first of all, to Mrs. Patsy Clay, who has done a superb job not only coordinating the work of the authors but doing the initial editing and assisting them with their special problems. We are appreciative to Mr. Dan Slotton, who is responsible for the medical illustrations. He has been associated with the Ear Research Foundation in Los Angeles, directed by Dr. Howard P. House, who has kindly given us assistance in the past. To Mr. William Watson goes the credit for the photography. Our special thanks to Dr. Warren L. Jones for his advice in structuring the book and to Mr. Marvin Selter for his work as a special consultant. We also thank the Board of Directors of the TMJ Research Foundation (Arthur L. Neft, Frank Lanterman, Sidney Adair, Myrtle Atwater, Robert Baker, Robert Coffman, Mary Gaston, Adrienne Morgan, James Perez, William Ivers, Robert Van Aken, Thomas Wright, and Lawrence Burr) and the White Memorial Otolaryngology Foundation, Inc., for their support and encouragement.

We owe a great debt to Dr. Leland R. House, Head of the Department of Otolaryngology and Head and Neck Surgery at the White Memorial Medical Center in Los Angeles, and President of the White Memorial Otolaryngology Foundation, Inc. Without his help and encouragement this book would not have been written.

Douglas H. Morgan
William P. Hall
S. James Vamvas

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PART
ONE

GROWTH AND DEVELOPMENT

1

Embryology and evolution

DONALD E. DOYLE, M.D.

The jaw joint holds a particularly interesting and peculiar position, historically, in the development of the vertebrates, of which man is thought to be presently the highest form. To be classified as a complete vertebrate, a creature must have developed not only a backbone but also biting jaws. A mammal is distinguished from all other forms of vertebrate animals by the relationship of its jaw-ear structure.[3] Perhaps even more significant to vertebrate evolution is the fact that the first true diarthrodial joint developed at the jaw. Definitive diarthrodial joints (eudiarthrodial joints) were probably first developed in the common ancestors of bony fishes and may have been part of the mechanism that differentiated the Gnathostomata from the Agnatha.[4]

Gnathostomes were the first jawed vertebrates, and the Agnatha were vertebrates without jaws. The Agnatha are thought to be the basic ground plan for the vertebrates, which developed with the evolution of the Gnathostomes. Therefore it may be said that the jaws lead the way in joint evolution.

THE MAMMALIAN JAW

There are several morphological features that mark the mammalian jaw and distinguish it from those of mammal-like reptiles, as well as from those of other lower orders. Among these is the fact that the lower jaw is made of just one bone and is known as the *mandible*. It is homologous with the dentary bone of reptiles, and, like that bone, all the lower teeth are attached here. The lower jaw is joined to the skull by a dentary-squamosal articulation, the squamosa being that part of the temporal bone which forms the upper part of the temporomandibular joint. The direct counterpart of the jaw joint of the reptile (the articular-quadrate joint) has no part in jaw support in the mammalian skull. These two bones (articular = malleus; quadrate = incus) are the ossicles of the middle ear of the mammalian skull.[3] Thus the jaw joint of reptiles is still present in mammals, but it has a decidedly new function.

The evolution of the lower jaw from a series of bones to a single bone is significant in that this form obviously provides a stronger and more rigid unit. This was necessary as the jaw became more important for biting efficiency. As the upper limbs developed, the function of prehension was no longer essential for the jaw, thus the need for greater efficiency in the mouth.

The biomechanics of the temporomandibular joint are affected in another way by the evolution of man as an upright animal. An animal that is basically horizontally oriented can accommodate a simple hinged joint. That joint swings widely downward because there is nothing below it, the neck and body streaming directly backward away from the head. Vertically oriented animals, such as man, have their neck running downward in close relationship to the posterior aspect of the mandible. The important conduits such as the esophagus and trachea are in front of this axis. Because the rear margin of the jaw would strike the rather large mastoid process, a simple hinge would not be possible in this upright animal. With full function, its symphysis would forcibly compress the trachea and esophagus against the hard vertebral column. However, add to the hingelike rotation of the joint a forward and downward sliding of the condyles on their respective articular eminences, and the jaw can open widely and, at the same time, be

brought away from impinging on the structure of the neck, which are so vital. Even a primate as close to man as the baboon cannot open his mouth widely without first swinging his head up and backward, which is in actuality placing the head in a horizontal relationship to the vertebral column.[3]

GROSS ANATOMY

A discussion of an anatomical entity, such as a functioning joint, requires consideration not only of the joint itself but also of the various attachments and encircling tissues. From the most basic viewpoint, a study of the temporomandibular joint must deal separately with the embryology of the temporal bone and that of the mandible.

The anatomy of the area will be described in Chapter 2. However, I will list the basic elements of the temporomandibular joint and comment to the degree that seems appropriate.

The bony elements are, of course, the mandibular condyle, the mandibular fossa, and the temporal bone. The muscular attachments to the temporal bone that are involved in the functioning of the joint are the masseter and temporalis muscles. Although there are several other muscles that have origins on the temporal bone, they do not act directly in joint function. The muscles of mastication that have origins or insertions on the mandible are the masseter, temporalis, lateral pterygoid, and medial pterygoid muscles. No true joint exists without ligamenture that provides the necessary biomechanical struts and hinges. For the temporomandibular joint, these ligaments are the articular capsule, the sphenomandibular, the temporomandibular, the stylomandibular, and the articular disc. In addition, there are two synovial membranes, one above and one below the articular disc.

The synovial membranes begin immediately at the edge of the articular covering. One segment runs along the bone to the limit of the joint space and then reflects back on the inner surface of the fibrous capsule with various degrees of thickness and laxity, depending on the amount of movement in that area of the joint. The disc is a special interarticular meniscus, which is interposed between the fibrocartilaginous coverings of the surfaces of the synovial membranes. It is tough but thin and is a fibrous plate with a few cartilaginous cells. It is attached all around to the fibrous capsule. It, itself, has heretofore been considered not to be covered by the synovial membrane; however, recent histological studies indicate that there is a synovial covering around the disc.[7] The disc receives fibers of the external or lateral pterygoid muscle, which attach near its anterior-medial margin.

EMBRYOLOGICAL DEVELOPMENT

Despite the relatively large size of both the temporal and mandibular bones, this discussion will center around a fraction of their combined masses. According to Baume,[1] the structures of the temporomandibular articulation have been found to originate from two different blastemas. They are situated at a relatively large distance from one another and grow at different rates. They are, respectively, the condylar blastema and the temporal blastema. The first evolves to contribute to the formation of the condylar cartilage, the aponeurosis of the lateral pterygoid muscle, the disc, and the capsular elements of the lower joint. The second develops the articular structures of the upper level.

The condylar blastema forms at the distal end of the primordium of the mandible, or dentary. The dentary begins to ossify in the symphyseal integument at about the seventh week of fetal life at approximately the 19 mm stage of fetal development. By the time the 22 mm stage, or eighth week, is reached, a significant amount of bone has been laid down in a platelike form lateral to Meckel's cartilage. Meckel's cartilage extends from the midline to the developing chin to the developing middle ear. Remember that, phylogenetically, the developing middle ear in the primate, and especially the human, was the initial jaw joint of the vertebrates. It is here in the middle ear region that the malleus, and probably the incus, develop as posterior extensions of Meckel's cartilage (Fig. 1-1).

The intermediate portion of Meckel's cartilage disappears, but its sheath will remain to persist in the formation of the anterior malleolar ligament and the sphenomandibular ligament.

When the embryo has reached the 24 mm stage, the pterygoid and masseter muscles have differentiated. At the superior border of the lateral pterygoid muscle and just mesial to the masseter muscle, there is a layer of mesenchyme. It is this bulk of mesenchymal tissue which is the anlage of the articular disc. It is separated from the blastema

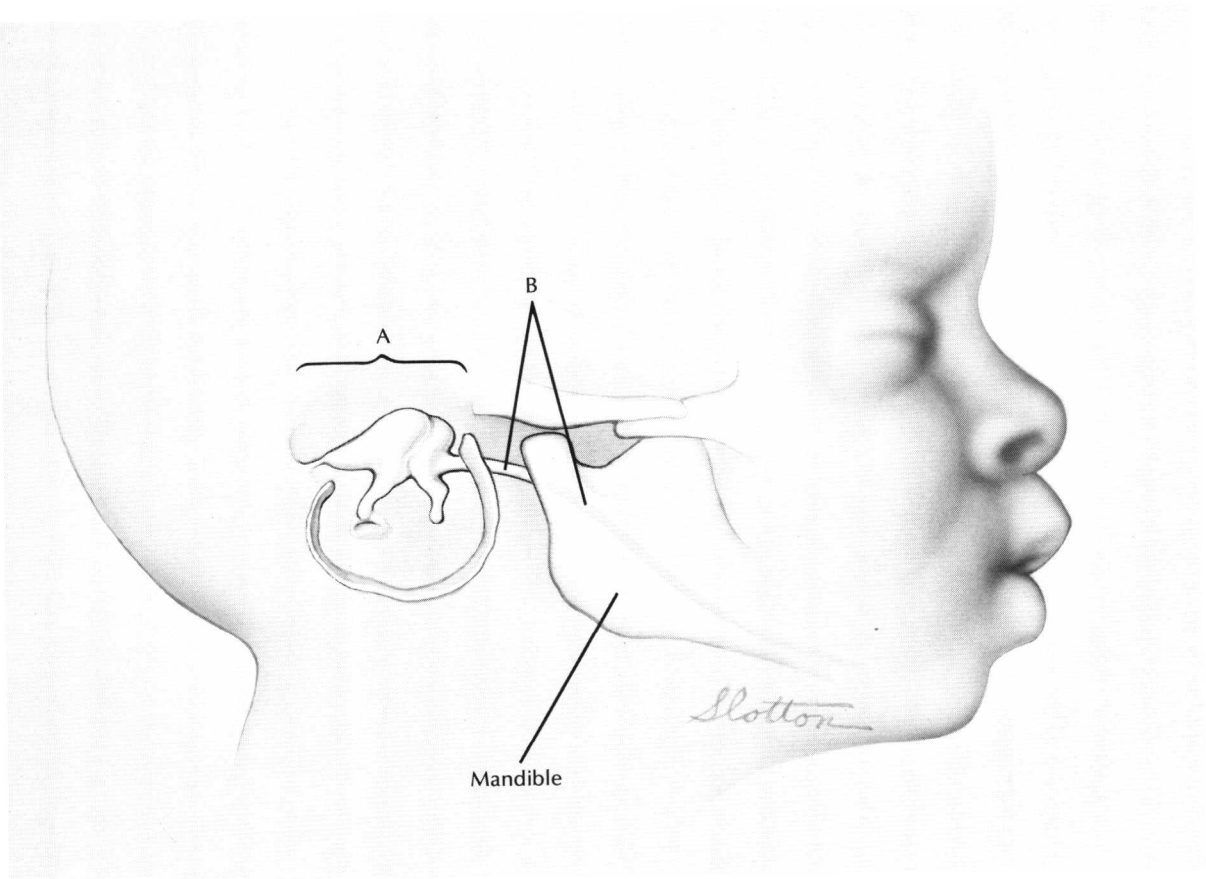

Fig. 1-1. Relationship of developing mandible to middle ear, *A*, in reference to Meckel's cartilage, *B*.

of the zygomatic process of the temporal bone by an area with few cells that develops, eventually, to become the superior joint cavity.[6] It should be pointed out, as a matter of interest, that at the 28 mm stage, the middle ear ossicles are fully formed in true cartilage, and the malleus is continuous with Meckel's cartilage. The articular disc and lateral pterygoid tendons are also attached to the malleus.

The condylar cartilage becomes an evident structure by the eleventh week. It is located at the upper end of the posterior border of the developing mandible. As the condyle continues to grow, its articular surface changes in shape. In the 30 mm embryo, its articular surface faces directly lateral.[6] It is parallel to the articular disc as well as to the articular surface of the zygomatic process of the temporal bone. The condylar cartilage shapes the articulating surface of the condyle in a hemisphere by the 50 mm stage of embryonic development. At the same stage, the articular disc has flattened, and the plane of the articular surfaces has undertaken a shift of 45°. The joint cavities have not completely formed yet, and the disc and the condyle are not in contact with the temporal bone.

At the 55 mm stage, the condylar head produces an osseous head and matures into condylar cartilage by the 65 mm stage, according to Baume.[1] This condylar cartilage begins ossification at the 85 mm stage, after which it is the growth center of the mandible. It is during this period that joint cavity formation becomes evident as the loose connective tissue on either side of the future articular disc becomes less dense. The inferior portion of the

joint cavity begins to take on the appearance of a distinct cleft.

About the time the embryo has reached 13 weeks of development, the lower joint cavity is fairly well formed around the superior surface of the mandibular condyle. The upper part of the joint cavity is also becoming a distinct entity during this period. By the time the fifteenth week of fetal development has been reached, the vascular mesenchyme of the condylar cartilage can be seen breaking down. Both joint cavities are formed by this stage. Differentiation continues anteriorly to arrive at a point of full articulation at the 155 mm stage, and all elements of the joint are fully formed at the 190 mm stage. As Baume[1] points out, full differentiation of all articular elements by the fourth fetal month is in keeping with a general embryogenetic law that all vital organs are formed by this stage.

JOINT INNERVATION

Development of the innervation of the joint has been recently described by Kitamura.[5] The joint is innervated by branches of the auriculotemporal nerve, masseter nerve, and the posterior deep temporal nerve, which are all branches of the mandibular portion of the trigeminal nerve. From the

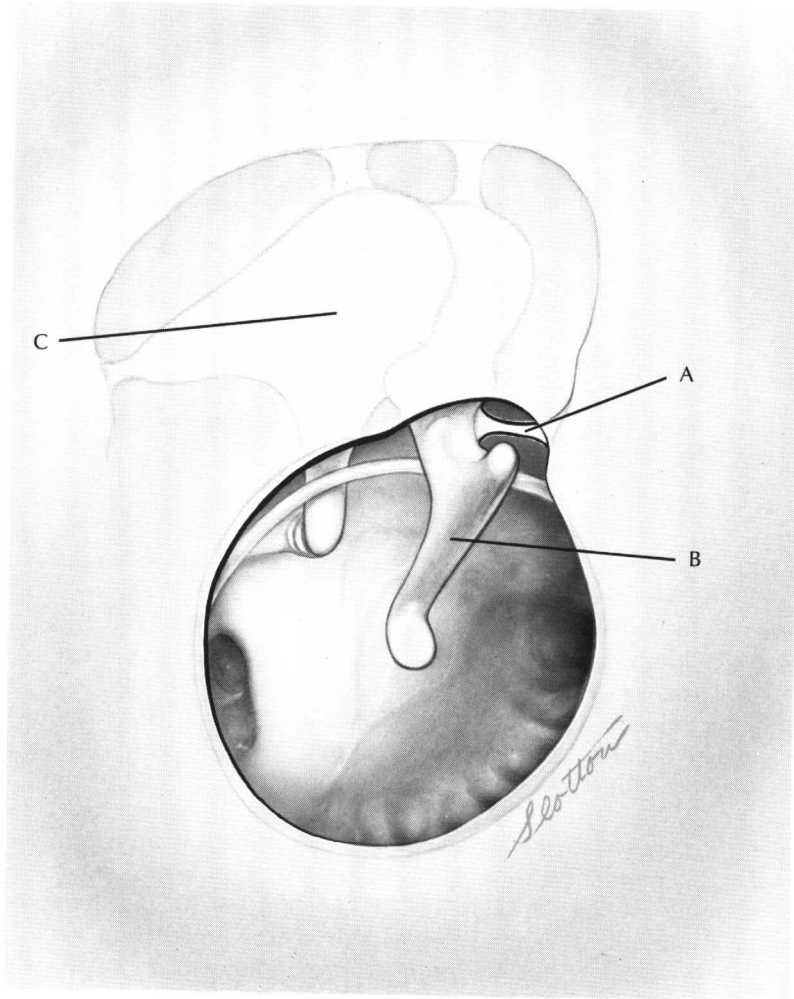

Fig. 1-2. Structures of middle ear that develop from Meckel's cartilage: anterior malleolar ligament, *A*, malleus, *B*, and incus, *C*.

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