Anatomy and Biomechanics of Condylar Fractures

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KEYWORDS

• Condylar fracture • Biomechanics • Anatomy • Temporomandibular joint

KEY POINTS

- The anatomy of the condylar region is complicated, but understandable and negotiable.
- The bilateral, diarthrodial nature of the mandible gives rise to unique biomechanical constraints that are altered by injury to the condyle.
- Understanding of the anatomy and biomechanics aids surgeons in diagnosis, appropriate treatment planning, and surgical approaches to condylar fractures.

Introduction

Facial fractures were described as early as the seventeenth century BC in the Edwin Smith surgical papyrus.[1] In the eighteenth century, the French surgeon Desault[2] described the unique propensity of the mandible to fracture in the narrow subcondylar region, which is commonly observed to this day. In a recent 5-year review of the National Trauma Data Base with more than 13,000 mandible fractures, condylar and subcondylar fractures made up 14.8% and 12.6% of all fractures respectively; taken together, more than any other site alone.[3] This study, along with others, have confirmed that most modern-age condylar fractures occur in men, and are most often caused by motor vehicle accidents, and assaults.[4]

Historically, condylar fractures were managed in a closed fashion with various forms of immobilization or maxillomandibular fixation, with largely favorable results. Although the goals of treatment are the restoration of form and function, closed treatment relies on patient adaptation to an altered anatomy, because anatomic repositioning of the proximal segment is not achieved. However, the human body has a remarkable ability to adapt, and it remains an appropriate treatment of a large number of condylar fractures, including intracapsular fractures, fractures with minimal or no displacement, almost all pediatric condylar fractures, and fractures in patients whose medical or social situations preclude other forms of treatment. With advances in the understanding of osteosynthesis and an appreciation of surgical anatomy, open reduction and internal fixation of condylar fractures has become more prevalent. Zide and Kent[5] first outlined the indications for open reduction of mandibular condylar fractures in their classic article in 1983. Several surgical approaches have been described to access the condylar region, allowing anatomic reduction and trends toward earlier function of the condyle, reducing risks of ankylosis or reduced functional capabilities. However, there are some condylar fractures that continue to prompt debate among surgeons regarding the best course of treatment. Regardless of the management, the starting point is a thorough understanding of the regional anatomy and the biomechanics of the fractured condyle.

Overview of anatomy

Bony architecture

The mandibular condyle articulates with the squamous portion of the temporal bone to form the temporomandibular joint (TMJ). The concavity on the temporal bone where the mandibular condyle lies in the rest position is termed the glenoid fossa. Anteriorly is the articular eminence, which the condyle translates down during function. Posterior to the glenoid fossa is the tympanic plate, which tapers to the postglenoid tubercle. The condylar head is roughly 15 to 20 mm wide and 8 to 10 mm long.[6] The articular surfaces are covered with a fibrocartilage connective tissue.

Temporomandibular joint disk

The TMJ disk lies between the mandibular condyle and temporal bone, separating the joint into 2 compartments: superior and inferior (Fig. 1). It is thought that it forms under compression during development from the posterior insertion of the lateral pterygoid muscle to the Meckel cartilage.[7] The disk is a biconcave structure composed of dense fibrous connective tissue, and is commonly described as having 3 discrete zones: thick anterior

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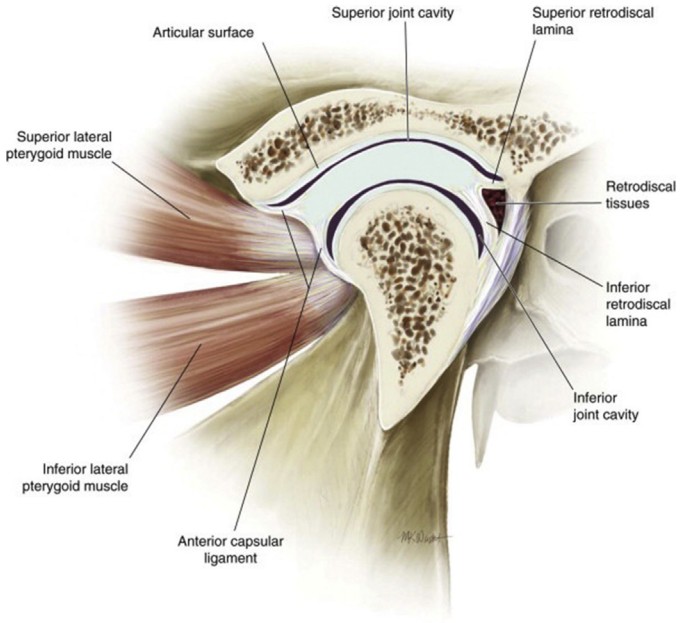

Fig. 1 Lateral view of the TMJ. (*From* Morris, C. The anatomy of the face mouth and jaws. In: Kademani D, Tiwana PS, editors. Atlas of oral and maxillofacial surgery. St Louis (MO): Saunders; 2016. p. 48; with permission.)

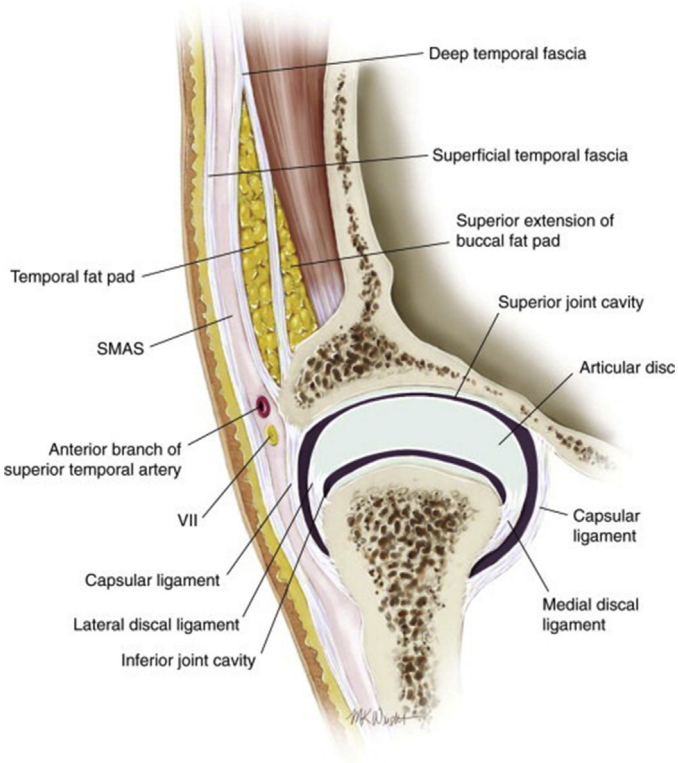

Fig. 2 Anteroposterior view of the TMJ. Expanded view also shows the position of the facial nerve when in the temporal danger zone. Note that superior to the zygomatic arch, the temporalis fascia splits into superficial and deep with an intervening temporal fat pad. SMAS, superficial muscular aponeurotic system. (*From* Morris, C. The anatomy of the face mouth and jaws. In: Kademani D, Tiwana PS, editors. Atlas of oral and maxillofacial surgery. St Louis (MO): Saunders; 2016. p. 48; with permission.)

and posterior areas bridged by a thinner intermediate zone. The central portion of the disk is devoid of vascular supply or innervation, which are supplied from the periphery, predominately by the retrodiskal tissue.[7,8]

Capsule and ligaments

The capsule encloses the TMJ complex. It contains a synovial membrane on the inner aspect, which is responsible for the production of the synovial fluid that fills and nourishes the joint space. It is formed by the medial and lateral capsular ligaments, which span from the mandible to the temporal bone. Inside the capsule are the medial and lateral diskal ligaments, or collateral ligaments, which connect the disk to the poles of the condyle (Fig. 2). The lateral ligament, or temporomandibular ligament, overlies the capsule, extending from the lateral aspect of the temporal bone to the neck of the condyle. The lateral ligament consists of a horizontal component that resists posterior displacement, and an oblique component that limits rotational movement, and is considered to play an important role in joint stabilization. The strength of this ligament may in part be responsible for causing condylar neck fractures below its insertion.[7]

There are 2 noncapsular ligaments that have limited functional impact on the joint, but are routinely described for sake of completion. The sphenomandibular ligament extends from the spine of the sphenoid bone to the lingula of the mandible, and is derived from the Meckel cartilage.[9] The stylomandibular ligament attaches to the styloid process of the temporal bone and the posterior angle of the mandible, coursing between the masseter and medial pterygoid muscles.

Muscles of mastication

The 4 primary muscles of mastication that act on the TMJ are the lateral and medial pterygoids, the masseter, and the temporalis (Fig. 3). All 4 are innervated by the anterior branch of the mandibular division of the trigeminal nerve. Although anatomic variances exist, the lateral pterygoid is most commonly composed of 2 distinct heads.[10] The superior head originates from the base of the greater sphenoid wing and inserts into the auricular disk. The inferior head originates from the lateral surface of the lateral pterygoid plate and inserts on the pterygoid fovea, on the front of the condylar neck. Their action together serves to pull the condyle and the disk simultaneously down the articular eminence. MRI and cadaveric studies have also identified a third head to the lateral pterygoid muscle in a portion of the population, which inserts in the TMJ disk and may play a role in disk stabilization.[11,12] The medial pterygoid muscle originates on the medial surface of the lateral pterygoid plate and courses laterally, inferiorly, and posteriorly to insert at the inner surface of the mandibular angle. Together with the masseter, the two make up the mandibular sling. The masseter originates from the inferior zygomatic arch, inserts on the lateral ramus, and has 2 heads, as shown in Fig. 3. The temporalis is a fan-shaped muscle with a broad origin along the lateral temporal bone, which inserts as a tendon along the coronoid process and anterior ramus, and as such is the most powerful adductor of the mandible.[7] Although several other muscles, such as the digastric, suprahyoid, and infrahyoid muscles, are involved in mandibular function, they are weaker muscles, whose role in mouth opening is aided by gravity.