The Comparative Anatomy of the Internal and External Pterygoid Muscles

Functional Variations Among Species

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A description of the differences in function of the muscles of mastication in various species, with a caution to consider those variations in any attempt to relate animal findings to the human masticatory mechanism.

Disorders associated with the temporomandibular joint are receiving much attention from all disciplines in dentistry today, and the anatomy and function of this area has been the focus of much of that attention. The use of laboratory animals in some related scientific investigations makes it timely to consider the comparative anatomy of some of the key muscles involved. This can help assure that research results are based on conditions actually comparable to those in man.

The masseter and temporal muscles are treated in great detail in anatomy books, but the pterygoids usually receive no more than passing mention. Close examination of many dissection guides seldom reveals any directions at all for examination of the pterygoids. The result has been that they are not well understood by many whose clinical efforts really require a complete knowledge of these muscles.

It has long been obvious to clinicians that there is a relationship between the teeth, the temporomandib-

ular joint and the ear. Pain symptoms in the joint or in the ear which are relieved by dental measures make the existence of the connection clear, but efforts to establish direct anatomic relationships are usually unsuccessful.

While the functions of the temporal and masseter muscles seem reasonably consistent even across species, pterygoid functions vary tremendously with the chewing patterns of the individual subject.

The temporalis (Fig. 1) arises on the side of the head above the jaw, converging downward and inserting on the coronoid process of the mandible. It is always capable of exerting both closing and distal traction on the jaw. Variation in the relative size of the elements of this muscle, as well as its overall size, relate to requirements to hold the head of the condyle up and posteriorly in the glenoid fossa.

The masseter (Fig. 1) arises principally from the zygomatic arch, providing closing force on the mandible.

Those two muscles are composed of many small elements with unique orientations and fiber makeup. Their selective activation makes many variations in the upward directional movements of the jaw available.

The pterygoids are situated where they can perform quite different functions. Becht[2] has suggested three divisions of animals based on these functions:

The flesh eater
The grass eater
The rodent and lagomorph.

To those we may also add the anthropoids.

Carnivores

The carnivores have teeth and a TMJ designed for simple vertical cutting motions.

In the cat, the external pterygoid arises from the lateral surface of the perpendicular plate of the palatine bone and the surface of the pterygoid process of the sphenoid bone (Figs. 1a and 2a). It inserts into the medial surface of the mandible between the opening of the mandibular canal and the base of the angular process (Fig. 2a).

The internal pterygoid arises from the surface of the pterygoid process of the sphenoid almost as a distal extension of the external pterygoid (Figs. 1a and 2b). It inserts in the ventral surface of the external pterygoid and the medial surface of the angular process (Fig. 2b).

Consideration of the functions of these muscles reveals that they are poorly situated to exert adductive force; rather, they exert a more or less horizontal force. Their function in the carnivores is to hold the cutting edges of the teeth snugly together in closing, for the greatest possible cutting efficiency. The pterygoid fibers also run at an angle to either the long axis of the skull or the body of the mandible, so there is an effective forward force vector in addition to that toward the midline.

Even in the carnivores, where guidance of jaw function by the teeth is so obvious, the pterygoid muscles also exert a protrusive force on the mandible.

Herbivores

In the herbivores the teeth and the TMJ are designed to grind the food by transverse movements, primarily horizontal.

In the sheep, the internal pterygoid arises from the ventral and lateral parts of the pterygoid and palatine bones and from the pterygoid process of the sphenoid bone (Figs. 1b and 3A). It is inserted into the angle of the mandible and the medial surface,

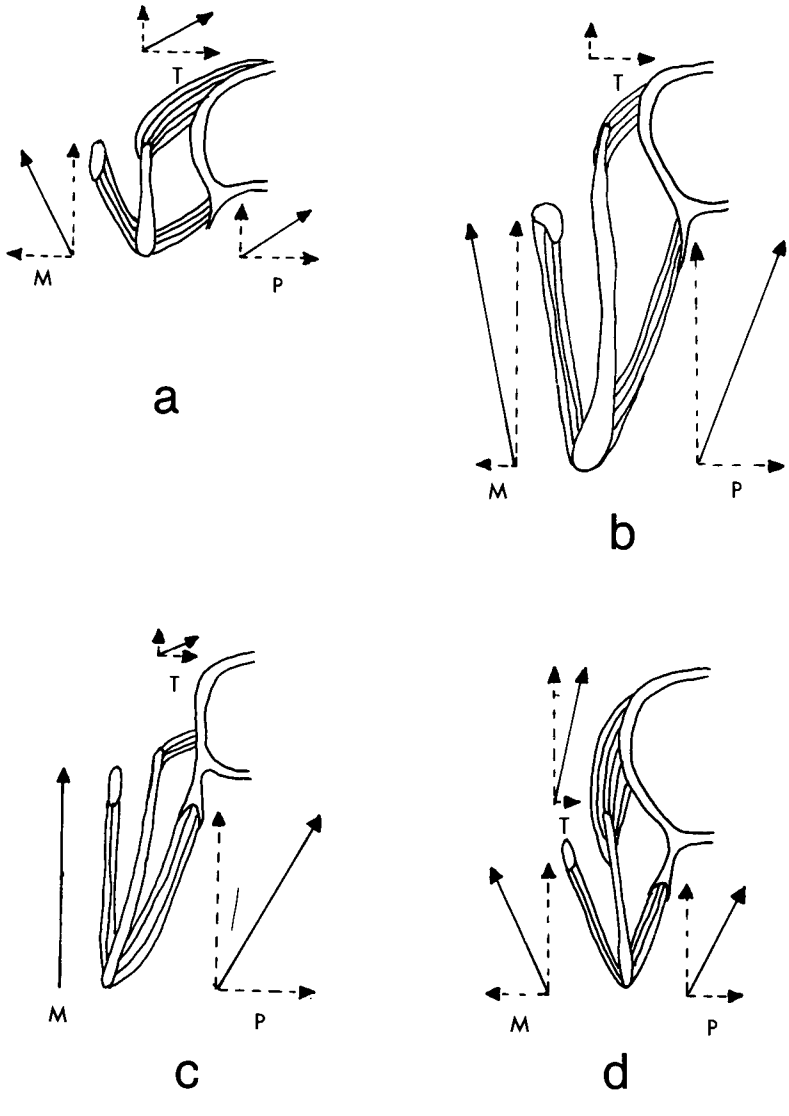

Fig. 1 Comparative anatomy of the force vectors of the internal pterygoid, the masseter and the temporal muscles. The plane of the illustration is based on a cut to separate the anterior part of the head from the posterior part at the level of the zygomatic arch. In each case "M" identifies the force vector for the masseter muscle; "T" the vector for the temporal; and "P" the internal pyerygoid.

a Cat b Sheep
c Rabbit d Monkey

vertical and caudal borders of the ramus (Fig. 3A).

The external pterygoid arises from dorsal and caudal parts of the pterygopalatine fossa, dorsal to the origin of the internal pterygoid and pterygoid crest of the sphenoid bone. It is inserted into the medial surface of the mandible above the mandibular foramen, on up to the head of the condyle, and into the articular capsule and the meniscus (Fig. 3B).

Fresh dissection makes it clear that contraction of the internal pterygoid in the sheep brings the mandible upward and medially, but the fibers of the external pterygoid are oriented so that they produce an anterior pull on the mandible at the head of the condyle. That protrusive movement contributes little if anything to the closing action.

Of equal interest are the three distinct layers of the masseter muscle. The most external layer arises from a thick tendon far forward, where the maxilla curves to join the zygomatic arch (Fig. 4). It inserts by a broad tendon over the distal and ventral borders of the mandible. This portion of the masseter muscle quite obviously exerts a tremendous protrusive force on the sheep mandible.

The other two layers of the masseter arise in more familiar fashion from the zygomatic arch and insert all along the lateral surface of the mandible and on up the ramus and coronoid process. At the deepest insertion on the coronoid process the fibers are closely mingled with those of the temporal muscle.

Rodents and Lagomorphs

The rodents and lagomorphs have posterior teeth generally designed for crushing and chewing movements, with incisors highly specialized for a vertical shearing stroke.

The articulation between the skull and the lower jaw is of such a nature that the mandible can slide backward and forward in relation to the skull as well as move up, down and sidewise.

The cheek muscles also reflect this movement pattern. These movements are accomplished variously in the rodents and lagomorphs according to the manner in which the several layers of the masseter muscle are arranged on the side of the skull.[5]

The internal pterygoid in the rabbit originates from the pterygoid process of the sphenoid. The insertion covers most of the medial aspect of the mandible behind the insertion of the digastric (Figs. 1c and 5a).

The external pterygoid is divided into two distinct parts, one running vertically and one horizontally. The superior head originates on the sphenoid bone behind the pterygoid process and inserts on the medial surface of the ramus of the mandible (Figs. 1c and 5b). The inferior head, which lies at a right angle, originates on the pterygoid process and inserts on the anterior and medial surfaces of the neck of the mandible (Fig. 5c). Thus, the superior head raises the mandible while the inferior head moves it forward.

Anthropoids

The teeth and the TMJ of anthropoids appear to be well adapted to a wider range of foods with little need for further specialization. They are probably not as efficient in specialized areas as either the pure herbivores or carnivores, but they represent a satisfactorily efficient compromise for a wide variety of foodstuffs. The pterygoid muscles reflect this and are clearly divided in location and function.

The internal pterygoid in monkeys arises from the inner surface of the lateral lamina of the pterygoid pro-

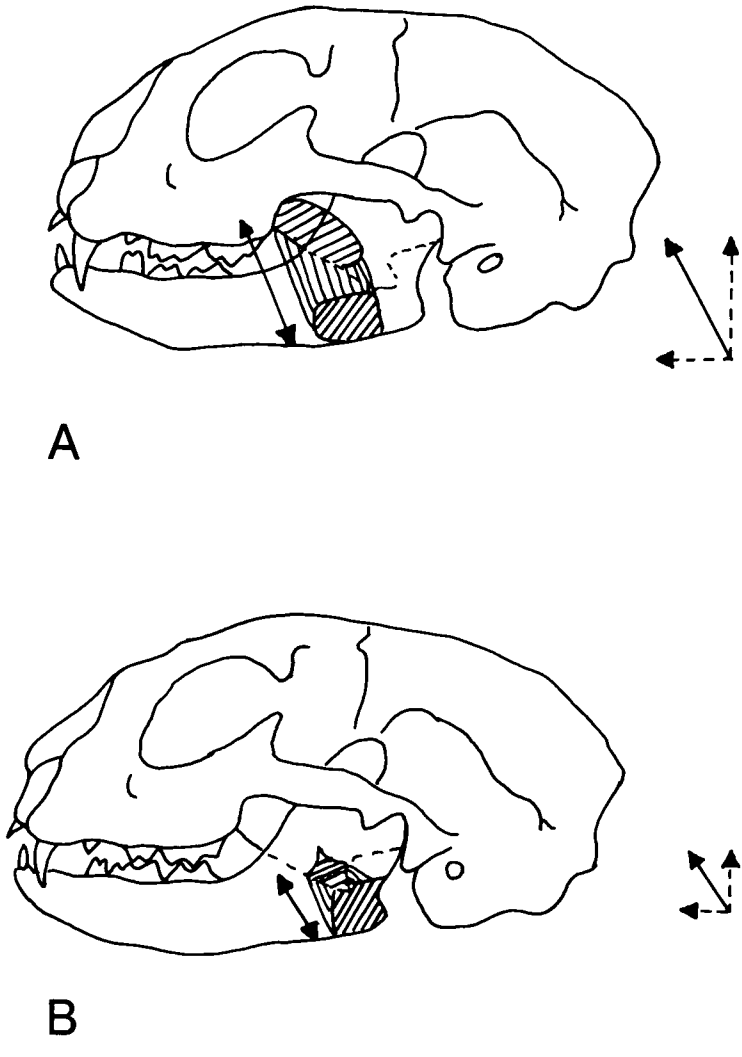

Fig. 2 The vectors of force of the pterygoid muscles of the cat. Top, External pterygoid. Bottom, Internal pterygoid.

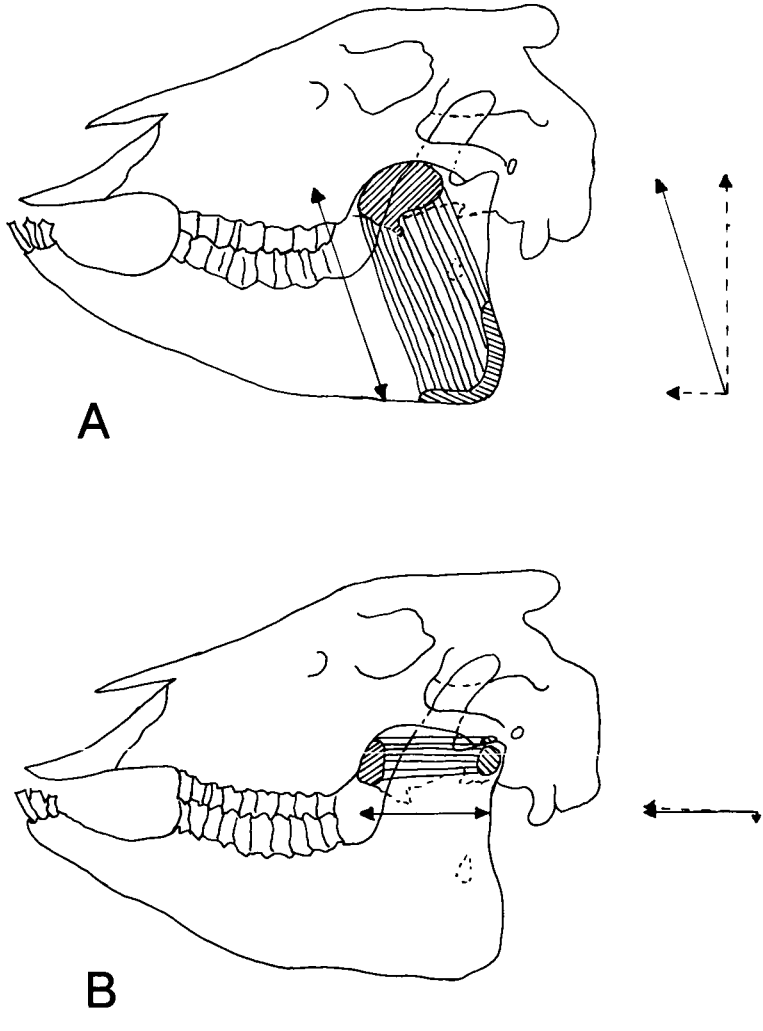

Fig. 3 The vectors of force of the pterygoid muscles of the sheep. Top, Internal pterygoid. Bottom, External pterygoid.

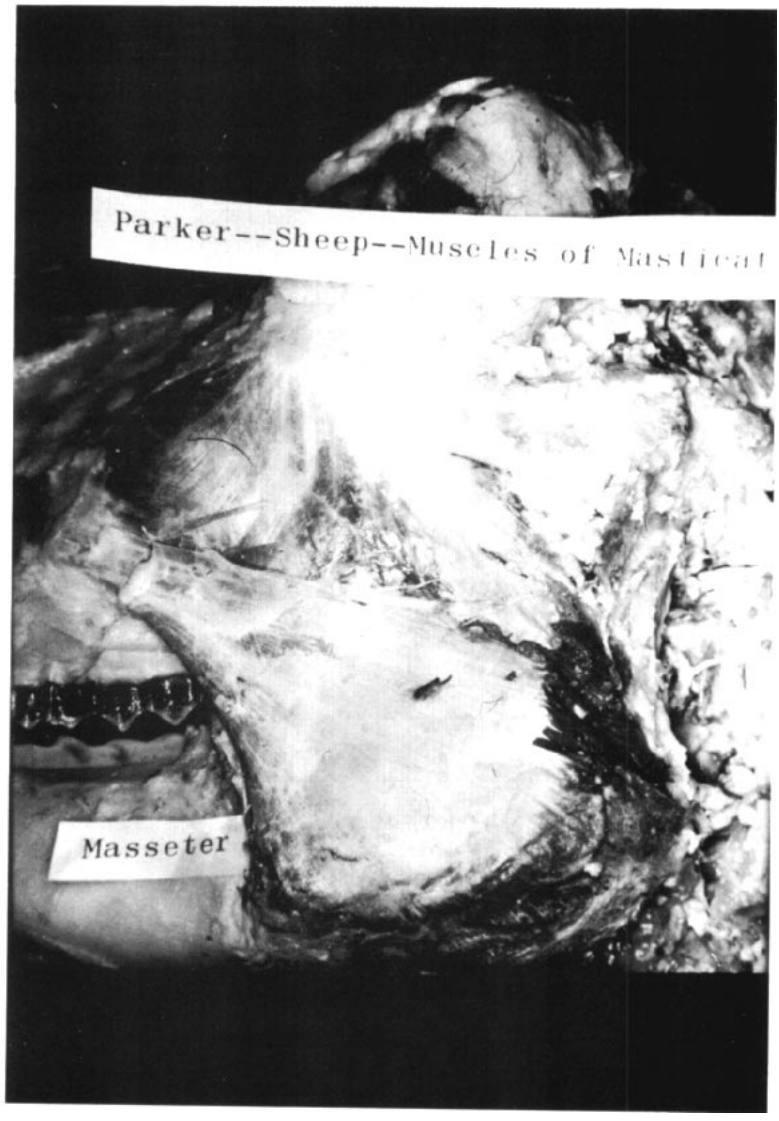

Fig. 4 In the sheep the third layer of the masseter is shown here in a fresh dissection. The narrow but heavy tendon inserts far forward on the maxilla.

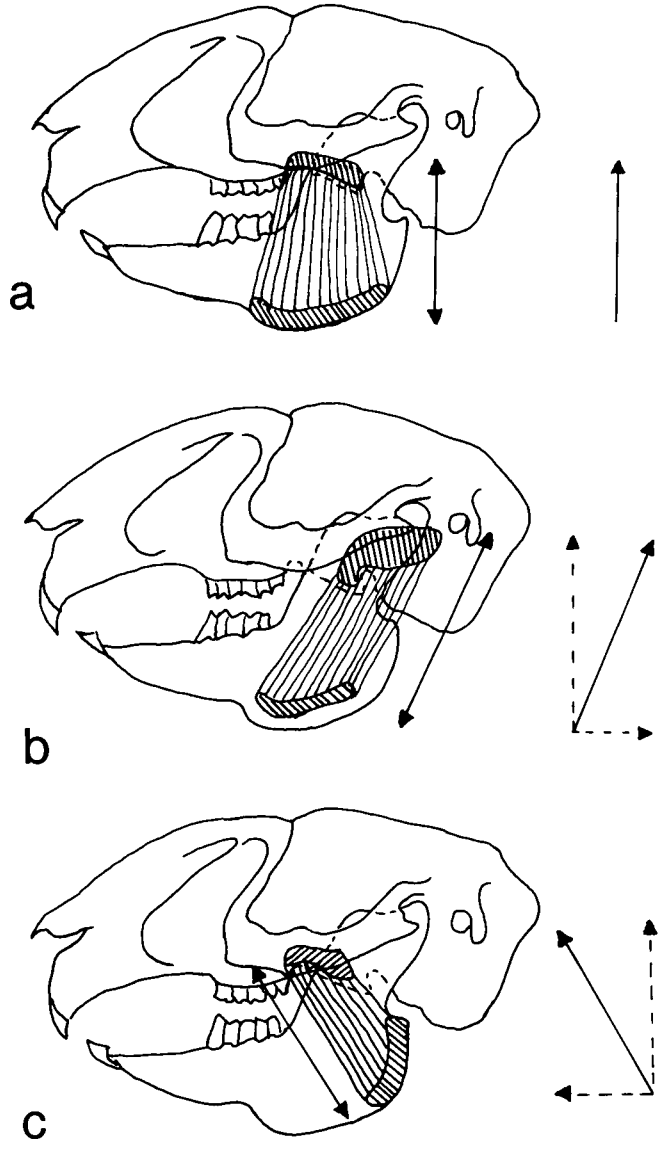

Fig. 5 The vectors of force of the pterygoid muscles of the rabbit. Top, Internal pterygoid. Center, Superior head of external pterygoid. Bottom, Inferior head of external pterygoid.

cess and passes downward and backward to insert on the angle and posterior part of the ascending ramus of the mandible as high as the mandibular canal (Figs. 1d and 6a).

The external pterygoid arises in two heads (Figs. 1d and 6b). The upper head arises from the infratemporal crest and the greater wing of the sphenoid bone, the lower from the lateral pterygoid plate. They converge posteriorly and attach to the pterygoid fossa of the mandible, the capsule and the articular disc of the joint.

The presence of large canine teeth in the anthropoids presents an interesting puzzle. In the sizeable group of carnivores with large canine teeth, these teeth and the TMJ permit basically only vertical motion of the man-

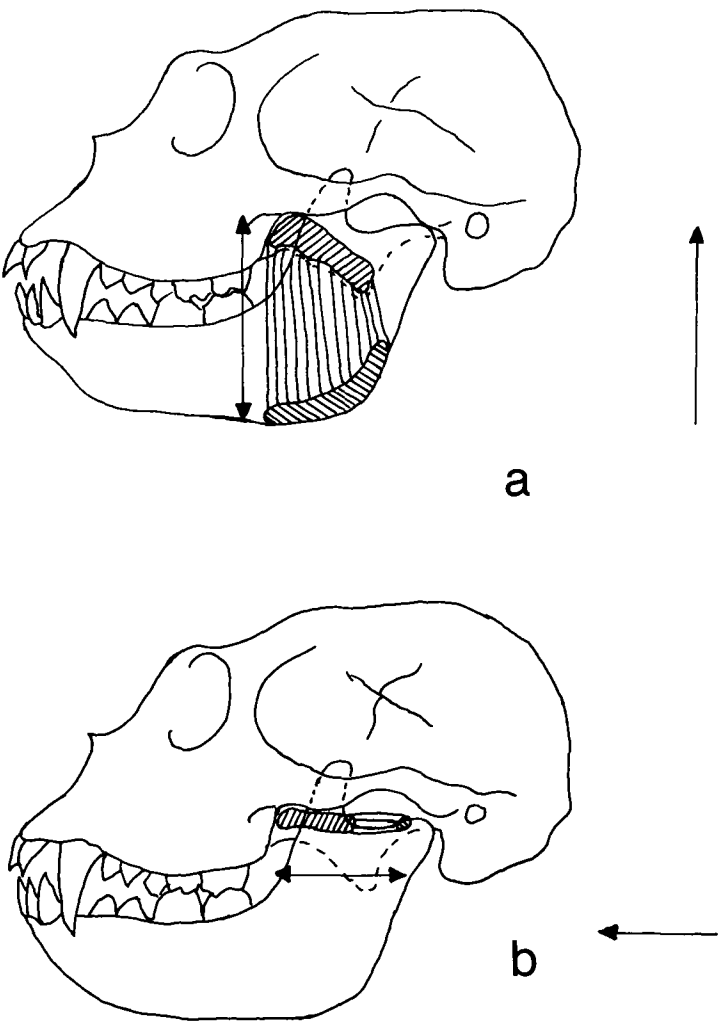

Fig. 6 The vectors of force of the pterygoid muscles of the monkey. Top, Internal pterygoid. Bottom, External pterygoid.

dible. Both carnivore pterygoids are oriented to produce a medial force in concert with that vertical action. The head of the carnivore condyle is at the level of the occlusal plane.

With few exceptions, those mammals with non-meat diets have the head of the condyle well above the occlusal plane. The internal pterygoid is oriented for adductive motion and the external pterygoid for protrusion. Although the canines are highly developed in some cases, large interlocking canine teeth are exceptions among the herbivores.

The anthropoids have the head of the condyle well above the occlusal plane, with the external and internal pterygoids also arranged as in the non-flesh eaters. The large interlocking canines resembling those of the flesh eaters are therefore a curious addition from the opposite type of functional pattern.

The anthropoid TMJ is also between those two extremes, neither as free-wheeling as that of the herbivores nor as tight as that of the carnivores.

Other studies of function of the muscles of mastication have concentrated on comparison of muscle weights,[1] with some minor attention to the influence of the direction of action of the pterygoids. From this cursory review of the literature and the four different animal types dissected, it would appear that detailed studies would reveal a high correlation between feeding functions and the functional orientation of the pterygoid muscles.

This should provide a note of caution to researchers who wish to relate their animal research in this area to human problems. The question that must be asked is whether or not the muscles and related dental function in the chosen animal are comparable to those in the human.

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