Repositioning of the Masseter Muscle and its Effect on Skeletal Form and Structure

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INTRODUCTION

The influence of function on the form and structure of bone has provided much discussion in the past. Experimental interference with muscle action in growing animals has demonstrated that growth of bones can be adversely affected. Washburn[1] found that removal of various portions of the zygomatic arch without disturbing the masseter muscle in one-day old rats produced skeletal asymmetries of varying degrees. Horowitz and Shapiro[2] have shown that interference with muscle function in thirty day-old rats produced skeletal alterations comparable to those observed by Washburn. Sassouni[3] hypothesized an archial concept of the facial musculature into anterior and posterior vertical chains. The anterior archial chain of muscle corresponds to the incisors and the posterior chain to the molars. In skeletal open-bite cases the posterior vertical chain of muscles has little influence on the molars.

In order to minimize the mesial component of forces, a theory was advanced for a surgical repositioning of the muscles more anteriorly in the gonial area of the mandible. This would bring the molars under the influence of the posterior vertical chain of muscles.[4] This procedure differed from the previous studies in that the masseter muscle was unilaterally reinserted surgically about one centimeter more anteriorly in the gonial area of the mandible in twenty-eight day-old dogs to study the resultant changes in the bone form.

It was felt that a study of this nature would give some clues regarding the interaction between muscle and bone and a future possibility of a surgical treatment in skeletal malocclusions.

METHOD AND PROCEDURE

Twelve mongrel terrier dogs from three litters were used at the age of about twenty-eight days at a time when each weighed approximately 1.5 kilograms. The masseter muscle was unilaterally repositioned anteriorly at its insertion on the corpus under intraperitoneal sodium pentothal anesthesia in nine dogs. One dog from each litter served as a control animal.

Sterile surgical technique was used throughout. The skin was incised from the angular process in an anterior direction roughly paralleling the lower border of the mandible to the midpoint of the mouth. The second connecting incision was made superiorly from the angular process to the anterior portion of the external ear.

After reflecting the skin and superficial fascia, the masseter muscle was exposed by blunt dissection. A Batson Carmody elevator was used to separate the ventrolaterally and ventromedially attached fibers; they were then

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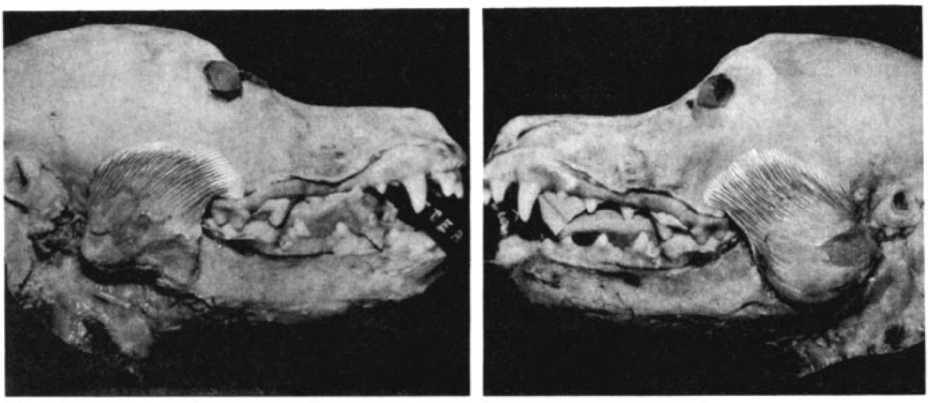

Fig. 1 Both masseter muscles have been dissected. The right repositioned muscle is smaller in bulk and the direction of fibers are more vertical than oblique compared with the left normal side.

cut from the surface of the bones. The inferior stump of the muscle was clamped with a hemostat.

All of the muscle was cut with the exception of a few fibers of difficult access adjacent to the tympanic bulla and the coronoid process.

The free end of the muscle was reattached with catgut noninterrupted sutures to the underlying periosteum, about one cm anteriorly from its previous insertion. The skin incision was closed with noninterrupted 4/0 braided silk sutures. A funnel-shaped collar was placed on the neck extending beyond the incision area to protect the wound. All operated animals were given 600,000 units of procaine penicillin - G, I.M. every 24 hours for a period of five days.

The operative procedures were essentially identical on all the dogs except that five dogs were operated on their left sides and four dogs on their right sides. The postoperative recovery period was rapid and with no untoward effects. After their maximum growth achievement, the animals were sacrificed at approximately nine months of age.

After fixation of the heads, the masseter muscle was exposed on both sides to observe the direction and new attachment of the muscle.

Results

The following gross deviations occurred as a result of unilateral repositioning of the masseter muscle.

Masseter Muscle:

The masseter muscle on the operated side was uniformly smaller in bulk. The direction of the muscle fibers was more vertical rather than oblique as in the normal side, i.e., the backward directions of the fibers was less evident. The total length of the muscle was short due to its more vertical insertion in the corpus (Fig. 1). The point of insertion of the masseter muscle on the operated side was five mm forward from its normal position. This verification of the success of the operative procedure was found by superimposition of oriented radiographs of the right and left sides of the mandibles. The insertion of the muscle was not well marked, but showed some intermingling of the fibers with the associated muscles.

Mandible:

There was a lateral sweep of the body of the mandible between the first and second molars on the operated side.

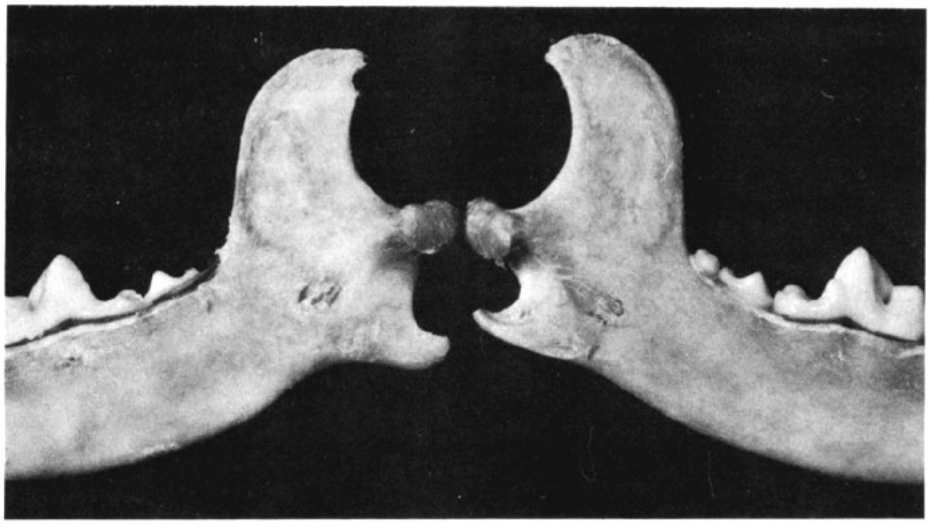

Fig. 2 The angular process shorter and less massive, very shallow antegonial notch, shorter distance between the condyle and the angular process, after repositioning of the masseter muscle shown on the left mandible. Normal mandible on the right.

Anterior to this area there was no apparent deviation. The antegonial notch was either absent altogether, or very shallow, as compared with the normal side. The angular process was shorter in size and relatively less massive with some cases showing slight medial deflection. A considerable change was noted between the distance from the angular process to the condyle. On an average this distance was about four mm shorter than on the unoperated side (Fig. 2). Very insignificant changes were noted in the configuration of the condyles.

There were no appreciable gross changes observed in the coronoid process and masseteric fossa. The overall dimensions of the mandible were not affected.

Skull:

There was a slight deviation of the snout toward the operated side at the level of the first premolars. The condylar fossa was shallow; otherwise, the size and shape were the same. The zygomatic arch and facial bones were not at all affected.

Dental Arch:

The interocclusal distance at the premolar area was greater than on the normal side. The midlines were off and deviated toward the operated side. In general there were no appreciable changes in molar occlusal relationship, but at the incisors there were several deviations such as anterior openbite, edge-to-edge bite, and incisal crossbite. The malrelationship was due to the individual normal variation and possibly has no relation to the muscle repositioning.

Discussion

Unilateral repositioning of the masseter muscle causing some lack of muscular balance between the two sides resulted in very little change in skeletal form. This indicates that the imbalance created in the muscle system was not of an extreme degree, such as that produced in the unilateral removal of the muscles which results in asymmetries of the jaws. The procedure under study here is probably more comparable to the bilateral removal of the masseter

muscle where none of the asymmetries were observed.[2]

The qualitative differences induced in this study by changing the point of insertion of the most powerful masticatory muscle should show some changes in form especially in a young, growing animal, since form and function are seemingly interdependent. However, in this study the changes in form were of a limited nature. The following are suggested as possible explanations of this result: first, compensatory muscular activity, and second, the stabilizing influence of the forces of occlusion. The imbalance in the muscle system created a functional demand on the associated internal pterygoid and digastric muscles which enabled them to maintain the jaw in position or to overcome the muscle pull on the unoperated side. This compensatory muscle function represents nature's attempt to establish a balance between the skeletal, functional, and environmental components.[5]

A differentiation has to be made between the temporomandibular joint and the manner of occlusion in dog and man. In the dog the temporomandibular joint resembles a hinge joint permitting only vertical movement of the mandible. The buccal vertical overlap relation of the upper cuspids, premolars and molars creates a mechanical block. This interlocking type of occlusion and the hinge joint does not allow any eccentric movement of the mandible; in addition, it completely immobilizes the mandible in position allowing only vertical movements. The mechanical block created by occlusion and the manner of mandibular movements possibly prevented alterations in the size, shape and position of the jaws. It has been pointed out by Baker[6,7] that asymmetrical growth of the jaws and skulls occurred following the establishment of unilateral mastication by the removal of teeth or grinding them out of occlusion. In any event, we must recognize from this purely mechanistic analysis and an understanding of biologic principles that it may not be possible to relate the results obtained in this study to man.

It is clear that, while the relation of muscle function is important in determining the size and shape of the jaws, there are other factors involved such as the forces of occlusion and compensatory muscle activity and growth potential. The discrepancies demonstrated at the antegonial area and angular process resulted from an inhibition of the subperiosteal cellular activity due to a decrease in muscular action at the area of insertion of the masseter muscle. This agrees with Washburn[1] and Avis[8] that the surface features of the bone are dependent on muscle action stimulation. Murray[9] cites numerous experiments which show that the basic form of the adult bone is laid down very early and is controlled by intrinsic factors rather than muscle function. However, the quantitative alterations in the size and shape of the angular process from the normal may be attributed to lack of functional stimuli. The normal process of surface apposition and resorption was inhibited and the angular process remained the same as it was prior to the surgical procedure. This accounts for the shorter distance on the operated side between the angular process and the condyle. It seems evident that functional stimuli are of some importance in enabling a growing animal to reach its normal adult form.

A slight deviation of the snout toward the operated side was noted, similar to the situation observed by Walkhoff[10] which he ascribed to the loss on that side of the "influence of function on growth."

The fact that the overall dimensions (height and length) of the mandible remained the same indicate that these

changes in form are limited to local areas.

Summary

1. The masseter muscle was surgically unilaterally repositioned anteriorly at its insertion on the corpus in nine young dogs.
2. Postoperatively the angular process was shorter in size and relatively less massive. The antegonial notch was absent. The distance from the angular process to condyle was much shorter. Overall dimension of the mandible in size, shape and position was not affected.
3. The findings support the concept that the superstructures of the bone are dependent on the muscular action.
4. The limited change was accounted for by two factors:
   a. The muscular compensation action of the associated muscles and growth potential.
   b. The immobilization of the mandible due to the occlusal interlock of the teeth and the hinge type of temporomandibular joint which precludes any lateral type of movement of the mandible.
5. This study cannot be directly related to man as the compensating factor of the occlusion and temporomandibular joint are different.

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