Experiments with Unilateral Bite Planes in Rabbits

H. G. Sergl, Dr. Med. Dent.

Mehdi Farmand, Dr. Med. Dent.

Introduction

The insertion of unilateral interocclusal bite planes provides a method to study the mechanisms of functional adjustment. This experimental procedure causes a displacement of the functional equilibrium of the masticatory system. As a consequence, certain structures are increasingly stressed during mastication, other structures are freed of masticatory stresses, and the muscles of mastication are stretched.

Various tissues may be involved in the adjustment process, especially those which have a particular role in mastication, i.e., the teeth, periodontal tissue, bones of the jaw, temporomandibular joint, other facial skeletal bones, condylar ligament capsule and the muscles of mastication.

A number of experiments involving interocclusal bite planes have been described in the literature. Most of those studies have been related to the question of how increased stress affects the surrounding tissues and the bone supporting the teeth. In other words the studies[1,5-20] have been concerned primarily with "occlusal trauma." Frequently the experimental design required that the crown or onlay inserted to raise the vertical dimension of occlusion was forced to bear the entire burden of mastication until such time as an adjustment of the entire dentition had resulted by remodeling.

Consequences of such measures uniformly have been reported to include expansion of the periodontal crevice, loosening of teeth, thrombosis formation in the vessels, necrosis of the periodontal membrane and resorption of the cementum, dentin and of the bone of the alveolar walls. This has led to intrusion of the overloaded teeth and, as a consequence, to equilibration of occlusion or loss of occlusion. Insofar as observations were continued for longer periods, extensive repair of tissue has been reported.

Simultaneous overloading of several teeth has led to similar results by Glickman and Weiss.[6] But restoration of an equilibrium condition in these experiments appears to have resulted primarily through increased length of the unstressed teeth, Hoffer et al.[10]

Breitner[2,3,4] has reported extensive adjustment changes after the insertion of a bite plane in the region of the anterior and lateral teeth in monkeys. He found a depression of the stressed teeth and an increase in length of the teeth freed from functional requirements. He also noted bony apposition on the condyle and on the posterior border of the ascending ramus; bone resorption was seen on the anterior surface of the neck of the condyle, on the lower border of the mandible and at the angle of the jaw.

No uniform picture can be drawn from reported results of temporomandibular joint changes resulting from insertion of interocclusal bite planes. On one hand, after an assumed increased stress on the joint, thickening and growth of the cartilage layer has been seen;[10] on the other hand, flattening and shrinkage of cartilage cells have been reported under similar conditions.[17]

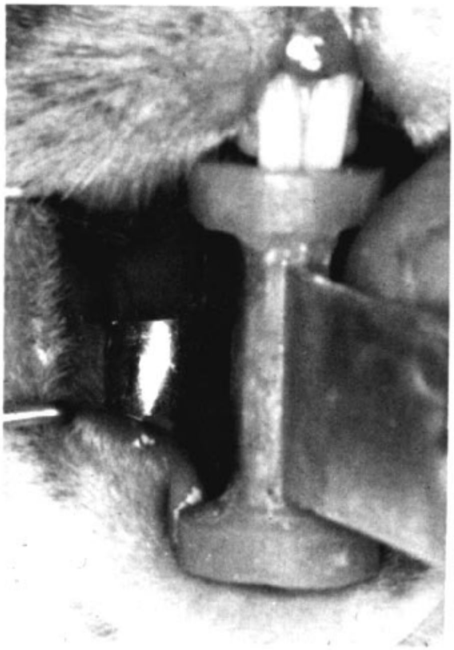

Fig. 1 Bite plane cemented on the right mandibular lateral teeth of a rabbit. Intraoral work in the animals was made much easier through the use of a bite block.

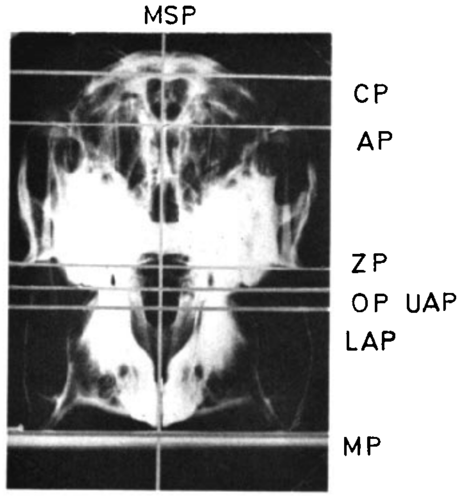

Fig. 2 Frontal teleradiograph of a control group animal.
MSP—median sagittal plane
CP—cranial plane
AP—articular plane
ZP—zygion plane
OP—occlusal plane
UAP—upper alveolar plane
LAP—lower alveolar plane
MP—mandibular plane
OP and UAP normally coincide

Methods and Materials

The experiments to be reported here were carried out on rabbits approximately twelve weeks old.

An impression was made of the right lower posterior teeth with the anesthetized animals. Bite planes were modeled, cast with a silver alloy and cemented in place (Fig. 1). The thickness of the interocclusal plane was approximately 3 mm corresponding to an elevation of the vertical dimension of 5-7 mm in the region of the anterior teeth.

The animals appeared to adapt relatively quickly to their new condition. After an initially reduced food intake, accompanied by slight loss of weight, they reached approximately the same weight as the average weight of the control group.

Each experiment lasted nine weeks. Animals which were lost before or during the experimental period for various reasons were replaced so that eight preparations suitable for evaluation were finally available at the end of the series of experiments. The skulls of eight similarly aged rabbits were available for comparison.

The heads of the killed animals were fixed in 10 per cent formalin. After removal of soft tissue, the skulls were photographed, radiographed and measured cephalometrically from various directions.

A frontal teleradiograph was prepared for each head at a distance of 2.5 meters. These films were evaluated according to a standard method which we developed (Fig. 2).

The separated mandibular sections were radiographed in lateral projection from a one meter distance. The out-

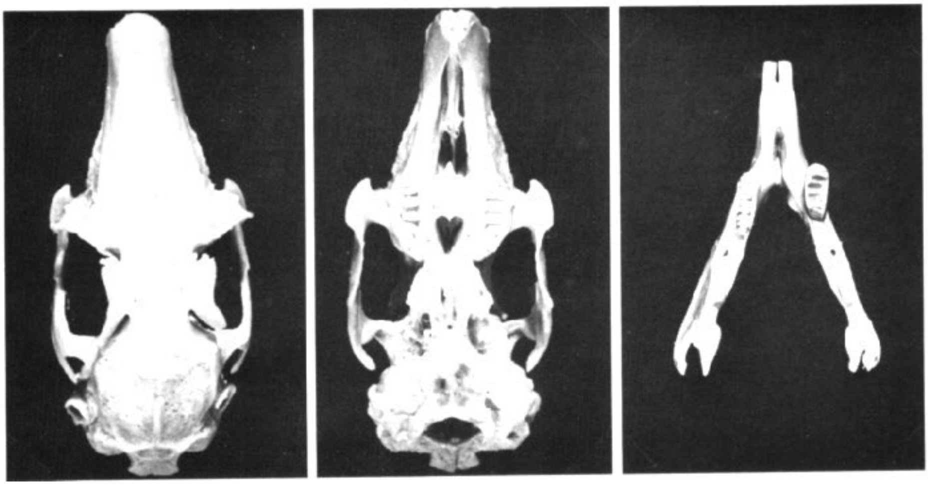

Fig. 3 A preparation with obvious cranial scoliosis.

lines of both mandibular halves were transferred to transparent paper from these radiographs and were superimposed in such a manner that the mandibular body was covered as much as possible.

Results

The differences in vertical dimension caused by the experimental measures applied had been equilibrated in all animals at the end of the experimental period. All teeth were in occlusion. The distance between the glenoid fossa and the condylar process was of equal size bilaterally.

A slight displacement to the left of the mandibular midline was obvious in six preparations; sometimes this was accompanied with an oblique abrasion of the incisors. Almost all the skulls of the experimental group showed evidence of more or less recognizable asymmetry in the form of skull curvatures toward the left, relieved side (Fig. 3).

The frontal teleradiographs (Figs. 4 and 5) of the experimental animals indicated a relative increase in the height of the lower skull portion involved in mastication in comparison with the control animals.

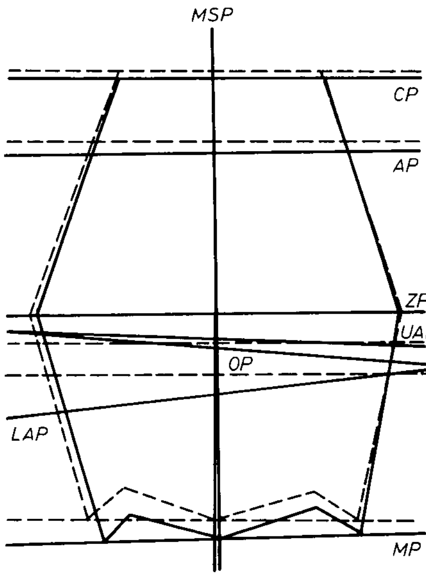

Fig. 4 Polygon constructed from averages of the single measurements of the frontal teleradiographs. See Fig. 2 for symbols. Solid lines, experimental subjects; dashed, controls.

This increase is somewhat greater on the right side (with the bite plate in place) than on the left. This leads to slanting of the mandibular plane (MP) downwards to the right. The lower alveolar plane (LAP) is slanted somewhat more downward to the right. The occlusal plane (OP) extends upward

Fig. 5 Photographs and frontal teleradiographs of two experimental animals. Horizontal planes as in Fig. 2.

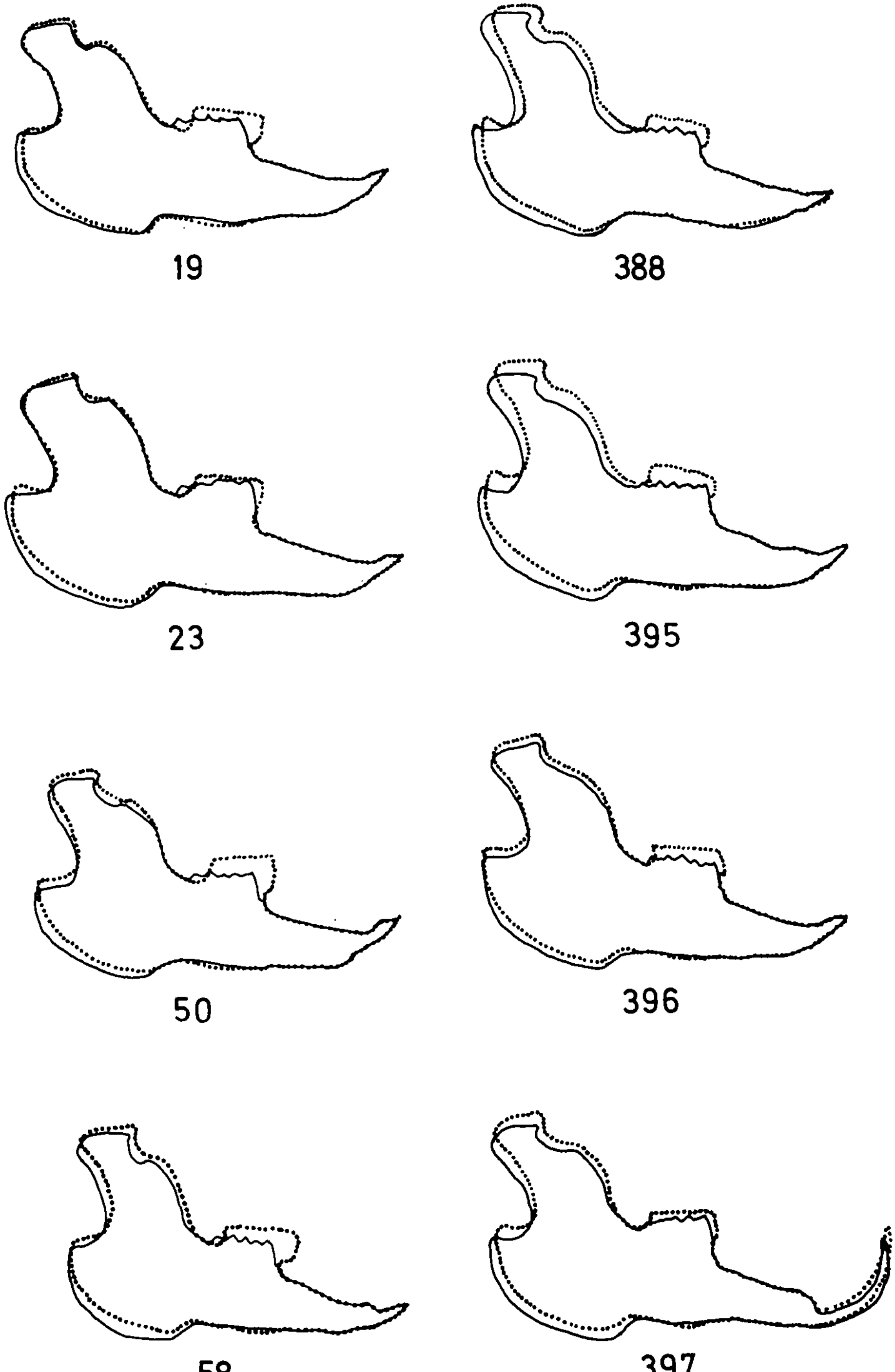

Fig. 6 Superimpositions of the outlines of the right and left mandibular halves. The right side (with bite plane) is shown in dotted lines. The drawings were constructed by superimposing areas of the mandibular body.

to the right. The upper alveolar plane (UAP), normally coincident with the occlusal plane, rises in most experimental animals to the right but less sharply than the occlusal plane.

This characteristic facial skeletal growth was found in almost all experimental animals provided with bite planes on the right lateral teeth. Preparations made from the control group (Fig. 2) are symmetrical in comparison. The transverse planes, described above, are perpendicular to the median sagittal plane (MSP) and parallel to each other.

Superimposing the outlines prepared from lateral radiographs of both mandibular halves shows that the position of the right ascending ramus is higher. Its relative position to the mandibular body has moved cranially. This change is recognizable in almost all of the preparations of the experimental animal group (Fig. 6). Vital staining of bone growth lines with alizarin Red S indicated that this displacement occurred because more bone is put down in the area of the condyle and less bone in the area of the angular process.

Discussion

In our studies we were concerned with the questions of whether adaptation takes places in growing individuals after insertion of a bite plane on one side and with the type of changes which take place in this adjustment. Animal experiments have shown that the adjustment occurs through the combination of several effects. The transverse course of the occlusal plane at the end of the experiment shows clearly that the eruption of the stressed teeth was inhibited while the relieved, contralateral teeth grew longer. The alveolar processes reflected these changes only in part, but in the maxilla their relative positions to the surrounding bones were changed, too, as shown by the course of the upper alveolar plane.

Displacement of the bone-supporting teeth also appeared in the mandible in the form of changed positional relations of mandibular body and ascending ramus. The appearance of such displacements may be explained by the fact that load relationships at the insertion of the large masticatory muscles and at the temporomandibular joint were changed by insertion of the bite plane. Because the mandible on the affected side was depressed in its entirety, the masticatory muscles of this side were stretched. This caused an increase in the distance between the glenoid fossa and the condylar process, relieving the temporomandibular joint. The pattern of bone growth was changed as a consequence of load variations. The condyle on the relieved side was the site of more bone growth and the muscle insertion sites had less bone growth until equilibrium was reached.

The cranial scolioses which were noted may also be referred to changed masticatory loading. This appears to indicate that forces transferred during mastication can affect growth of the skull.

Summary

1. Insertion of bite planes on the right mandibular lateral teeth of eight young rabbits caused load changes in the masticatory system. Eight other animals served as controls.

2. The induced changes were equilibrated during the nine-week experimental period by adaptation processes. At the end of the period all teeth were in occlusion and the glenoid fossa-condylar process distance was equal on both sides.

3. The adaptation was the result of several mechanisms working together. We found changes in the alveolar re-

gion and at distant growth structures. Cranial scolioses were observed.

4. Masticatory functional loading is a factor which regulates growth in the region of the facial skeleton.

Univ. Kieferklinik
65 Mainz
Augustusplatz 2
West Germany

Faculty of Dentistry
Univ. of Manitoba
Winnipeg, Manitoba
Canada

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