

MOUTHGUARDS:

Protection against shock to head, neck and teeth

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This five-year study of head and neck injuries suffered by college football players indicates that mouthguards may afford protection to structures other than the teeth. This added protection is especially evident among players prone to concussions or injuries to the neck and among those with preexisting injuries. In instances in which faulty occlusion predisposes the player to injurious traumatic shock to the head and neck, the combined use of an acrylic template and the mouthguard dramatically reduces the incidence of head and neck injuries. The repositioning of the mandibular condyle, cervical vertebrae and other anatomic structures, brought about by acrylic template and mouthguard, is shown graphically in tracings of the cephalometric roentgenograms of the players. The tracings also afford at least a partial explanation for the protection against traumatic shock that template and mouthguard provide the head and neck.

Our interest in mouthguards had a rather dramatic beginning in the fall of 1958, the start of the Notre Dame University football season. Jim Schaaf, now in the public relations staff of the Kansas City Athletics, was at that time a starting player for the team but, apparently as a consequence of concussion sustained during play, was sidelined suffering from a severe loss of equilibrium.

His condition had been tentatively diagnosed as Meniere's syndrome, and his ability to play football again was seriously doubted. Since he was a key player on the squad, the local newspaper kept readers informed about his lack of progress. Through Coach Terry Brennan we obtained permission to examine the patient, since we thought he might have a temporomandibular joint problem.

Examination of the boy's mouth revealed a beautiful dentition. Yet, when the cotton rolls were placed between his posterior teeth and he was instructed to swallow, his face suddenly lit up; he told us that it was the first time in three weeks that his ears had cleared. From this point on it was easy for us. We knew exactly what had to be done.

An interocclusal acrylic template (posterior occlusal acrylic splint) was made to cover all the mandibular posterior teeth, and a mandibular mouthguard was also constructed. The patient was instructed to wear the template (splint) at all times, changing to the mouthguard only when playing football. In a few days his equilibrium was normal, and in less than two weeks he resumed his starring role on the team. He finished the season with no difficulty.

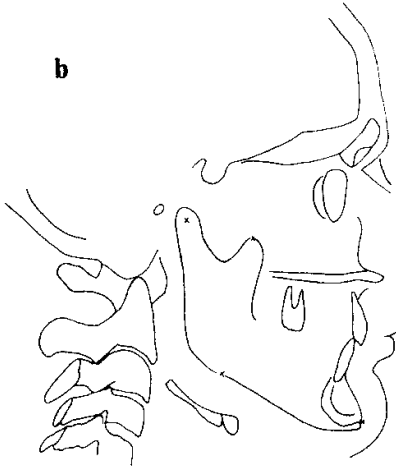
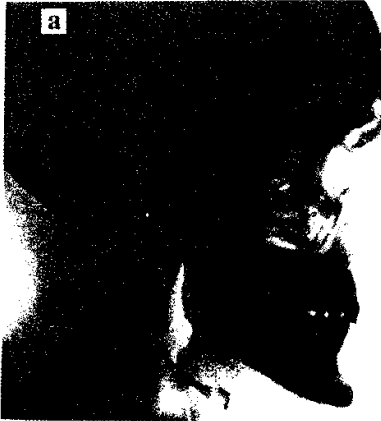
The interesting part of this story lies in the fact that

the patient had always been prone to concussion. This dated back to his high school days, when he had been selected an All American high school player. He could not recall playing in a game or scrimmage in which he had not been knocked partly or completely unconscious. (Concussion, as used in this article, refers to any loss of consciousness experienced by a player during contact, whether a momentary loss of consciousness or an amnesia-type disorder that lingers for hours.)

From the time he started wearing a mouthguard, though, his head remained completely clear at all times. In addition, Schaaf observed that, when he "hit really hard" after he started wearing his mouthguard, he did not experience the spinetingling electric shock from which he had suffered before. He finished the season at Notre Dame, played in the North-South All Star game in Miami, Fla., and played two years of service football after graduation.

Study of Mouthguards

Successful treatment of this patient led us to certain questions and, later, beliefs regarding oral, head and neck trauma suffered in contact sports. Our plan was to assess, initially, the general extent of use of mouthguards by players and their attitudes toward them; to review the three types of mouthguards available - stock, mouth-formed, custom made - to ascertain the most effective type, and then to determine in practical tests what effect, if any, it had in preventing and reducing injuries.



Our inquiry revealed that many players and coaches have an aversion to mouthguards. Thinking that such a "contraption" detracts from his appearance of "ruggedness," the player declines, with the silent consent of his coach, to wear it, in spite of the mounting evidence that wearing a mouthguard protects the neck and head in addition to the teeth. And yet, the equally rugged sport of boxing has long recognized the importance of the mouthguard; in fact, the California State Boxing Commission recently ruled that a fight must be stopped so that a lost "mouthpiece" can be reinserted.

Being in an area where both football and manufacturing are prominent, we were afforded access to facilities for collaboration in the laboratory development of mouthguards as well as to players for making practical observations.

We were extremely fortunate to have the cooperation of the conscientious trainer of the Notre Dame athletic teams, Gene Paszkiet, a man who shared our beliefs and made it possible for them to be tested in practical experiment in working with his team members. Through Gene Paszkiet, to whom we are particularly grateful, it was possible to compile the information and statistics which form the basis for much of this report. A special note of thanks is also due the CASAC Corporation, South Bend, Ind.

Experimentation and Discovery

We had been dissatisfied with the mouthguards that were commercially available and proceeded to set up certain criteria we thought should be met to achieve the desired physiological results. A mouthguard must:

1. Be custom-made to an accurate model of the player's mouth.
2. Be comfortable in wearing so that the player will accept it; edges should be thin.
3. Have sufficient retention to prevent accidental dislodgement during athletic contact or calling signals.
4. Be tough enough to prevent cuspal penetration; except in an unusual mouth, the mouthguard should provide at least two seasons' wear.
5. Be thermally resistant to enable sterilization by boiling or autoclaving and, also, be compatible with the oral tissues at cool temperatures.
6. Be chemically odorless and tasteless.
7. Receive approval of all components, singly and in combination, by the Food and Drug Administration.

During the 1962 football season we experimented with various materials in collaboration with a firm which manufactured several new types of mouthguards. None of these, however, proved completely successful under playing conditions. During 1963 spring practice, however, an entirely new type of mouthguard was designed.

It was a custom-made modified vinyl elastomer guard and proved extremely successful. The decision was made to equip the entire Notre Dame football team with this new model of mouthguard before fall practice began. Never before in the recollection of Trainer Paszkiet were there so few injuries of all types as during that 1963 spring session. As expected, injuries to the teeth and jaws were nil. Even more important, however, was the impressive reduction in concussions.

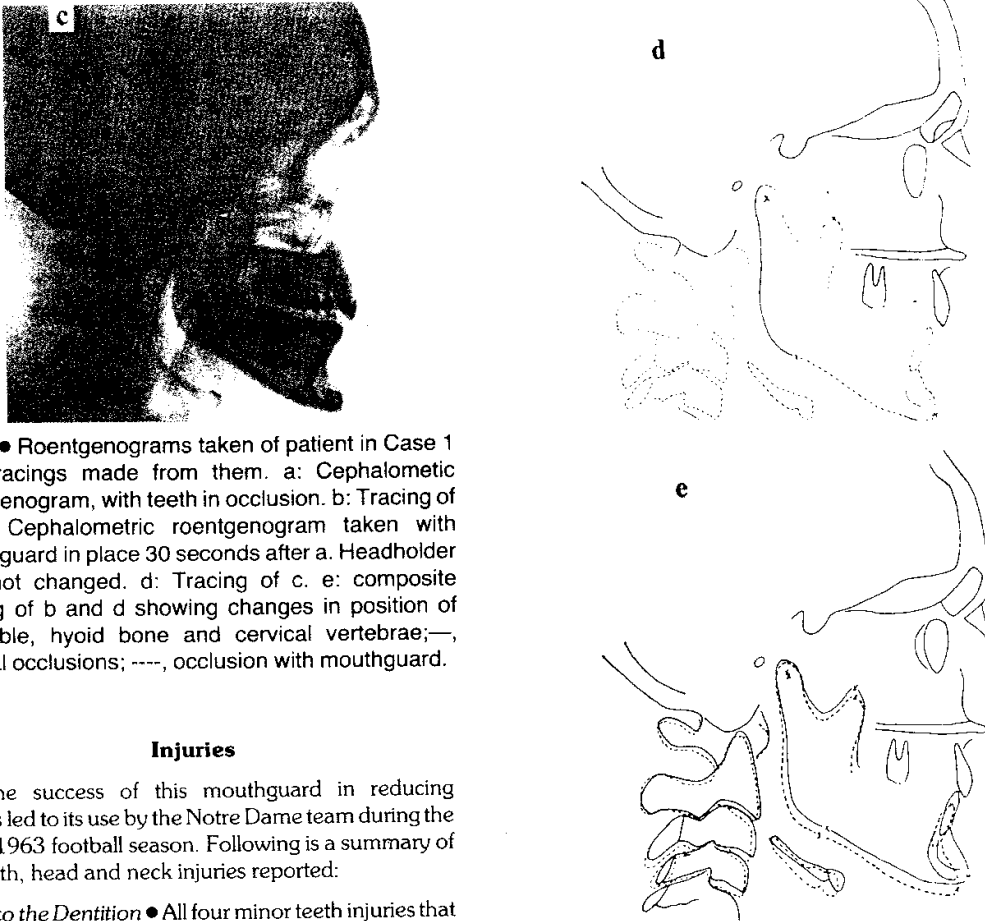


Fig. 1 • Roentgenograms taken of patient in Case 1 and tracings made from them. a: Cephalometric roentgenogram, with teeth in occlusion. b: Tracing of a. c: Cephalometric roentgenogram taken with mouthguard in place 30 seconds after a. Headholder was not changed. d: Tracing of c. e: composite tracing of b and d showing changes in position of mandible, hyoid bone and cervical vertebrae;—, normal occlusions; ----, occlusion with mouthguard.

Injuries

The success of this mouthguard in reducing injuries led to its use by the Notre Dame team during the entire 1963 football season. Following is a summary of the teeth, head and neck injuries reported:

Injury to the Dentition • All four minor teeth injuries that occurred during the 1963 season involved boys who were not wearing mouthguards.

Head Injury • There were ten concussions, and in only one instance was the player wearing a mouthguard. He was Bob Lehmann, captain of the 1963 team and an enthusiastic advocate of mouthguards.

Lehmann's medical history showed that, before wearing a mouthguard, he had been extremely prone to concussion. During his first season at Notre Dame, he suffered numerous concussions, recovery from which required several days of rest from play each time. The concussion he suffered while wearing his mouthguard lasted only 20 to 30 seconds, and he engaged in contact work the next day. (Cephalometric roentgenograms of Bob Lehmann are presented later in this article to show the structural changes that occur when a mouthguard is worn.)

Neck Injury • A reduction in the number of neck injuries was an unexpected result of wearing the mouthguards. Neck injuries had increased since the use of the face bar had become mandatory. During the 1962 season at Notre Dame, six or seven players had chronic neck problems, and four of them wore cervical collars. Cervical traction was routine therapy for these players. An automatic traction device was ordered by the athletic department and delivered during the summer to replace the manual one in use. Fortunately, because of the mouthguards worn by the players prone to neck injuries, the new machine, ordered in anticipation of more injuries, has never been unpacked. Furthermore, not a single Notre Dame player who faithfully wore his mouthguard during the 1963 season found it necessary to wear a cervical collar.

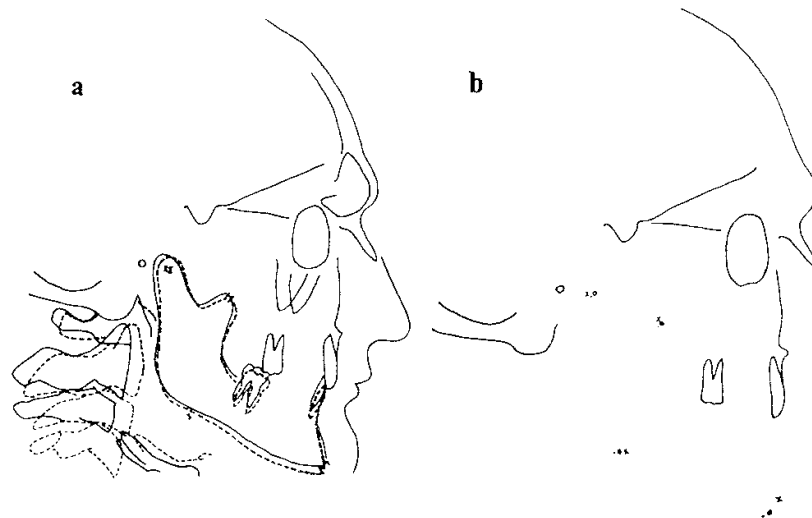


Fig. 2 • a: Composite of tracings of roentgenograms taken of patient in Case 2, original occlusion and occlusion with template removed three months later: —, original occlusion; ----, occlusion three months later. b: Mandibular position; x, original mouthguard, O, template.

Recurrence of old injuries convinced a few players who wore their mouthguards only occasionally of the merits of faithful and constant wearing. Tom Kostelnik, an end, had had a chronic neck problem diagnosed as a "pinched nerve" and had worn a cervical collar in the 1962 season. After wearing his mouthguard, his neck problem disappeared. On the one occasion he did not wear it, his neck problem recurred. He is a faithful wearer now and believes he can "hit much harder than before."

Three others had worn cervical collars the year before. Because of neck injury, one player had been removed from either a game or a practice session on six occasions during the 1962 season. He had also complained of pain that radiated down his arms into his fingertips and produced a burning sensation. Of these four players, only one required any neck traction therapy during the 1963 season, and then only two or three times.

Lateral Plate Roentgenographic Study

The following case reports, with the roentgenograms and tracings, show the method of study which produced the results described. All the men treated were team members of the Notre Dame football team.

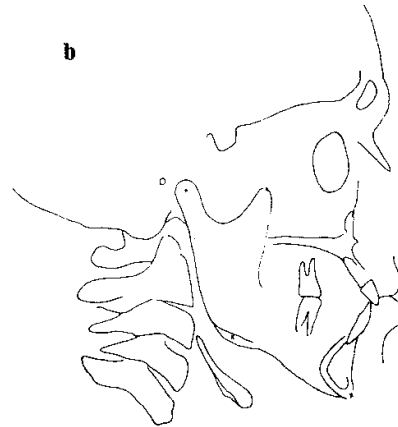
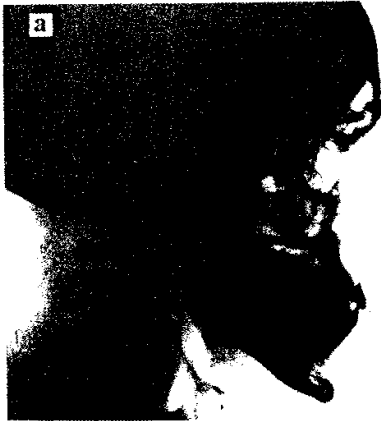
In each instance, before the use of this type of mouthguard, the patient had suffered, and was subject

to, injury on the football field. By using this mouthguard the patients were all relatively free of any type of disability from such injuries. The injuries to which these patients had previously been subject ranged from concussion and knockouts to neck injuries. This study was designed to reveal and explain the changes that occurred with the insertion of the mouthguard.

Each patient was seated with the head holder in position. A roentgenogram was taken with the patients' jaws in occlusion. Immediately the mouthguard was inserted, and a second roentgenogram was taken with the patient occluding his teeth with the mouthguard in position. No roentgenogram was taken with the patient's jaw in rest position, although it was observed clinically that no mouthguard exceeded in thickness the freeway space.

The roentgenograms were traced on acetate paper. The superior structures that do not change were superimposed. These structures include occipital condyle with base of occipital bone, external auditory meatus, sella turcica, anterior floor of cranium, orbit, frontal sinus and nasion and teeth in maxillary arch. All these structures were superimposed, with the changes in the inferior structures being noted. Such changes appeared primarily in the maxillomandibular relations, the hyoid bone and the cervical vertebrae complex. Four points were marked on the mandible itself:

1. On the condyloid process at approximately the inferior attachment of the external pterygoid muscle.



2. Tip of coronoid process at the insertion of the temporalis.
3. Inferior border of mandible.
4. Mental process.

The sequence of roetgenograms and tracings illustrate the various steps and points of the process (Fig. 1-4).

Case 1

Ron Jeziorski, a member of the Notre Dame 1963 freshman football team, was a long-time patient of one of us. He had a history of being concussion prone.

With treatment, the patient underwent the adaptations and corrections usually observed in denture patients and patients using templates (splints): the downward and forward changes in the condyloid process. The lower border of the mandible and the mental process region adapt to a downward position. The hyoid bone is in a backward and downward position. The whole cervical vertebral column moves to a more posterior position and seems to have a better relationship of the articular facets. The mouthguard does not permit the condyle to go back in the fossa and so prevents trauma from occurring in the condyle region itself and the structures posterior to this region. (Fig. 1).

The patient apparently had a traumatic relationship in his natural occlusion which predisposed him to injury in athletic activity. On at least two occasions, he had been hospitalized overnight for observation. He was told he would be almost immune to concussion if he wore a mouthguard. After two years of faithfully wearing a mouthguard, during which he had no injury, he said, "I would rather play without my shoulder pads than without my mouthguard."

Case 2

This case differs from the preceding one in that the patient not only had a functional problem, but also had a significant preexisting injury. We believe that the injury would not have been serious, or might have been avoided completely, if the patient's basic functional problem had been corrected.

Pat Bajdek, a lineman at Idaho State College, was examined on August 3, 1963. At that time, the patient experienced definite pain with crepitation on the left side when the temporomandibular joint was palpated. Muscle function was as follows: (1) masseter, very little; (2) anterior fibers of temporalis, normal; (3) posterior fibers of temporalis, none. Opening was normal with no severe deviation, but there was a jerky closure pattern. Freeway space was approximately 12 mm.

When questioned, the patient admitted that he suffered from dizzy spells after exercise with a slight tinnitis and stuffiness of the ears. He had no excessive drainage of either ear of any loss of hearing; he did complain of having a "cotton mouth" while exercising. The cervical pain extended halfway down his shoulder. The numbness of his right side caused his right hand to feel weak and heavy. He also experienced low back pain and mentioned that his back was usually taped during a football season to keep it from going out of position.

History and Treatment • The patient's health during childhood had been normal except for having rheumatic fever at age nine, which lasted one year and left no ill effects. His dental history was average except for extraction of lower left first molar in 1959 without replacement and for obvious overclosure and decided increase in freeway space.

A severe head tackle in October, 1961 resulted in

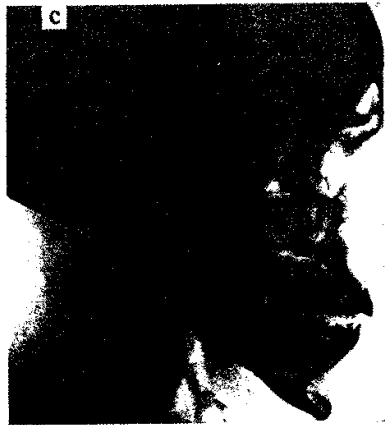


Fig. 3 • Roentgenograms of patient in Case 3 and tracings made from them. a: Cephalometric roentgenogram, with teeth in occlusion. b: Tracing of a. c: Cephalometric roentgenogram with mouthguard. d: Tracing of c. e: composite tracing of b and d; x—, original tracing; x-l---, with mouthguard.

slight concussion. From that date, he noticed a slight weakness in his right arm and some loss of equilibrium, which persisted for the remainder of the season. In September, 1962, after a severe head tackle, he "stiffened like a board." Losing all sensation on the right side of his body, the patient was unable to walk or move this side for hours. A pinched nerve in his neck was diagnosed, and chiropractic treatment somewhat relieved the condition. The patient subsequently suffered another concussion, and played the last game of the season in great pain. From that date (October, 1962) on, the patient experienced continual pain in the head, neck and right arm as well as numbness of the right arm.

In January, 1963, he was referred to an orthopedic surgeon, whose roentgenographic examination revealed no pathologic changes in the cervical spine. The surgeon instituted cervical traction in addition to hospital rest. Although the patient had decreased pain when completely inactive, he still had no actual relief by May, 1963.

In August, 1963, the patient returned to our office for models and rest position registration. He informed us that he was to be hospitalized for myelograms and possible surgery. The physician involved consented to postpone this at our request. While a template (splint) was being constructed, we asked the patient to wear a custom-made mouthguard constantly except when eating.

Four days later, when the template was delivered, the patient reported that, 24 hours after insertion of the mouthguard, his headache, neck pains and numbness of the right side had disappeared.

In four more days, strength began to return to his right hand, and he slept without difficulty. His template was adjusted in October, after he reported slight pain in his shoulder. By the end of October, strength had become almost normal, and he reported he hadn't "felt so good in over a year." routine examination in November indicated no problem.

Roentgenograms and Tracings • The patient wore the mouthguard while engaged in athletics, and at all other times the template has been worn. The first tracing shows the original occlusion (Fig. 2,A) and the occlusion three months later with the template out (Fig. 2,B). With the template out, only the anterior teeth were in contact (Fig. 2,B); later crowns will be placed to make the posterior teeth occlude. Also the muscles and ligaments have adapted back to normal to such a

degree that he cannot get the condyle back in the original traumatic position. This is not a matter of tooth depression, which would be impossible in such a short time, but rather has been muscle and ligament repositioning. Note the typical repositioning of the mandible and hyoid bone. The cervical vertebrae do not appear to be typical; this, we believe, resulted from the problem of positioning the patient at varying times in the head holder.

Another tracing that should be considered at this time is the master tracing in which the relationship of the three positions of the mandible in occlusion are superimposed (Fig. 2,C).

The main feature of this type of mouthguard is that it offers more suspension of the complete mandibular structure which, we believe, also means more protection for the individual from external forces.

In this case there were many factors to consider, of which time was the most important. Not only was the patient physically weakened in the head and neck, but these regions had been repeatedly traumatized. One year has passed since treatment was instituted. Exactly how much permanent damage was done before and after the serious injury that triggered these complaints is not known and is impossible to determine. Findings on all roentgenograms are negative. The only roentgenograms that shed any light on the problem are the cephalometric ones, indicating the change in the position of the cervical vertebrae and hyoid bone before and after the insertion of a template or mouthguard. The interpretation of these changes is beyond our scope.

Case 3

Bob Lehmann, guard and captain of the 1963 Notre Dame football team, affords an ideal case for tracing because the original roentgenogram was taken without changing the patient's position in the head holder (Fig.3).

The mouthguard was inserted and, at most, 30 second elapsed between the two exposures. As the patient bit on the mouthguard, typical adaptation of structure was observed. The entire mandible was put in a state of suspension so external forces were absorbed by the "shock absorber" mouthguard rather than being transmitted through the condyle to other parts of the head and neck. This suspension, incidentally, is the normal reaction observed when a patient is given the posterior support he has lacked because of either tooth loss or a faulty growth pattern in natural dentition.



Fig. 4 • Composite tracing of roentgenograms of patient in Case 4; x—, original occlusion; x- - - - , with mouthguard.

Case 4

The last patient we want to describe is Tom Kostelnik, whose case differs somewhat from the others in that the alteration of the structures was in the condyle itself. This movement was only slightly forward, rather than downward and forward as in the other patients, and so he required less mandibular suspension than the other patients did. There was only slight alteration of other structures in relation to the amount of alteration in the condyle region (Fig. 4).

Summary

By altering structures, the custom-fitted mouthguard provides protection and relief for patients with head and neck injuries from playing football. In four patients, roentgenograms were taken and tracings made, which illustrate the improvement seen when a custom-fitted mouthguard is used as therapy with an interocclusal acrylic template.

It is dentistry's responsibility to participate in the development of the best mouthguard possible. Achieving this goal will involve, among other things, consideration of all the traumatic forces which can be transmitted through the teeth or through the condyle. Achieving this goal will mean, for those engaged in active contact sports, protection of both the teeth and the head and neck structure in which the teeth are housed.