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Evaluation of mouthguards for the prevention of orofacial injuries during United States Army basic military training

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Abstract – Beginning in January 2000, all individuals participating in basic military training at Fort Leonard Wood, Missouri, were issued boil-and-bite mouthguards. From January 2000 to March 2001, trainees were required to wear mouthguards only for a single activity, pugil stick training. After March 2001, mouthguards were required for four activities including pugil stick training, unarmed combat, rifle/bayonet training, and the confidence/obstacle course. Dentists systematically tracked trainees who reported to the dental clinic with orofacial injuries during three periods: January 2000–March 2001 (phase 1), April–September 2001 (phase 2) and September 2002–June 2003 (phase 3). Orofacial injury rates were 3.35, 1.89 and 1.91 cases/10 000 person-years in phases 1, 2 and 3, respectively. The overall risk of an orofacial injury was 1.76 (95% confidence interval = 1.03–3.02) times higher in phase 1 compared with the combined phases 2 and 3 (P = 0.006). Thus, orofacial injury rates were lower when mouthguards were required for four training activities as opposed to one training activity. Mouthguards are now required at all five Army basic training sites when trainees are performing any of the four training activities.

Mouthguards have long been proposed as a major prophylactic device for minimizing dental trauma during sports and exercise (1–4). Primitive mouth protectors in the form of cotton, cloth, tape or court plaster were used by early boxers to protect their teeth and lips. Reusable mouthpieces were developed for boxers around the turn of the 20th century. They were initially controversial but subsequently adopted for general use in professional boxing (5–8). In 1960, the American Dental Association House of Delegates endorsed the use of mouthguards for football and other contact sports and the National Alliance Football Rules Committee mandated mouthpieces for high school football in the US beginning in the 1962 season (9–11). Since that time the National College Athletic Association has required the use of mouthguards for football (12), ice hockey (13), and lacrosse (14). The American Dental Association and the International Academy of Sports Dentistry currently recommend that mouthguards be used in 29 sporting or exercise activities. (15).

Studies that have examined the effectiveness of mouthguards are of highly variable quality (improper statistical analysis, inadequate or unclear methodological description, multiple interventions) and many require a secondary data analysis to adequately determine if mouthguards influence injury rates. However, with few exceptions (16, 17), studies examining sports injuries both prospectively and retrospectively (18–22) have suggested that mouthguards tend to reduce the incidence of orofacial injuries in rugby (21, 23, 24) (25, 26), football (19, 27, 28), basketball (22, 29) and a variety of other sports (18, 20). Mouthguards may also reduce the incidence of concussion but the evidence for this is less compelling (16–18, 20, 23, 29).

Previous studies that have examined the effectiveness of mouthguards have focused on sports activities. In addition to sport activities, tasks performed by specific occupational groups may incur some risk of orofacial injuries and use of mouthguards may help reduce this risk. For example, in a study of 16 military posts it was found that the overall rate of orofacial injuries was 37.7/10 000 person-years. This same investigation found that at military posts conducting Basic Combat Training (BCT) the orofacial injury rate was over two times higher at 83 injuries/10 000 person-years (30).

Fort Leonard Wood, Missouri, is a military post that currently conducts BCT and One Station Unit Training (OSUT). OSUT involves a combination of BCT with specialized training for enlisted military occupations like military police, combat engineering, and chemical operations. Anecdotal evidence from the Fort Leonard Wood dental clinic in 1999 suggested that trainees were experiencing a high rate of dental injuries. In an effort to decrease the incidence of orofacial injuries, the Dental Activity (DENTAC) Commander instituted a mouthguard program. The purpose of this paper is to describe this program and to report on the effectiveness of mouthguards in the prevention of orofacial injuries during basic military training.

Methods

Procedures

The Reception Station is the place where new Army trainees first arrive to complete medical and administrative processing prior to entering basic military training. The Dental Clinic staff at the Reception Station were trained by the DENTAC Commander on mouth protection and on the fabrication of boil-and-bite mouthguards. Most of the mouthguard program staff were formally trained dental assistants. The Fort Leonard Wood command staff who were involved with BCT and OSUT were briefed on the mouthguard program with lectures and data that supported the need for mouth protection.

A funding grant by the Health Promotion and Prevention Initiatives (HPPI) program administered by the US Army Center for Health Promotion and Preventive Medicine (USACHPPM) was used to purchase a supply of boil-and-bite mouthguards, a microwave oven and crock pots to fabricate the mouthguards. DENTAC teams were responsible for fabricating, fitting and providing mouthguards in the Reception Station Dental Clinic during trainee in-processing.

The boil-and-bite mouthguards were heated to the prescribed temperature in water that had been preheated in a microwave oven for 20 min and kept warm in preheated crock pots. Trainees were given the heated mouthguard and told to bite down gently and suck the air out of the mouthguard for 15 s, so that it adapted to the shape of the dental arch. After the mouthguard had cooled, trainees removed the mouthguard, and the dental technician checked to make sure that the mouthguard was properly formed without any distortion or bite-through. Trainees placed their finished mouthguard inside a small plastic bag provided for storage. The trainees then received their initial dental record and dental X-ray. Trainees also watched a video called *'Use 'Em or Lose 'Em'* to reinforce the importance of mouth protection and the requirement to wear a mouthguard during certain training activities. The mouthguard program added minimal time to dental inprocessing. During a timed assessment of the program, the Reception Dental Clinic provided mouthguards to 80 trainees in 12 min.

Fort Leonard Wood drill sergeants were responsible for ensuring that trainees wore mouthguards for required training events. Because the mouthguards were bright yellow, the drill sergeant simply asked the unit to 'Smile' to check to see that everyone was wearing their mouthguard. Soldiers who lost their mouthguards were instructed to tell their drill sergeant. Drill sergeants were given a supply of mouthguards and instructions on how to prepare mouthguards if they were needed by trainees.

Study design

The study sample consisted of all trainees in BCT and OSUT including Army, Army Reserve, and National Guard trainees. The first group of trainees began receiving mouthguards in January 2000 and subsequently all trainees arriving at the Reception Station were issued mouthguards. As mouthguards were given only in the Reception Station there were also a large number of trainees on post who had not yet received their mouthguards in January 2000. BCT takes 9 weeks to complete and OSUT units have variable timeframes ranging from 13 to 19 weeks. It was not until late April 2000 that all trainees on post had been issued mouthguards.

From January 2000 to March 2001, mouthguards were only required for pugil stick training. Program evaluation indicated that it would be beneficial to require mouthguards for other training activities. In April 2001, the mouthguard-wear policy was expanded to include rifle (M16)/bayonet training, unarmed combat, and the confidence/obstacle course. The program evaluation also indicated that drill sergeants were not systematically receiving spare mouthguards as planned to replace those lost by trainees. This problem was also corrected.

Data collection

Orofacial injuries were defined as damage to the teeth or soft tissues of the oral cavity, to include the lips and jaws. Orofacial injury data collection began in January 2000 at the trainee dental clinic. The treating dentists at the clinic were briefed on the study and recorded information on soldiers that presented to the clinic with an orofacial injury. The data was reported to the program coordinator each month.

The period from January 2000 to March 2001 when mouthguards were only required for pugil stick training was called phase 1. The period from April–September 2001 when mouthguards were required for all four training activities was called phase 2. Additional data was collected from September 2002–June 2003 (mouthguards required for all four activities) and this was called phase 3. No data was collected during the months of December (phases 1 and 3) because soldiers are sent home for the seasonal holidays during that time.

Data on number of trainees present at Fort Leonard Wood in each month of the evaluation was obtained from the Personnel Administration Office (PAO). These data were used to calculate the person-months. The PAO does not report personnel data for the month of December because of the training hiatus.

Activities requiring mouthguards

Pugil stick training involves face-to-face confrontation between trainees using a large pole that is thickly padded on both ends. Pugil stick training is designed to simulate close combat with an unloaded rifle. Trainees wear additional protective equipment including gloves, a football helmet, and shoulder pads. The goal is to knock the opponent to the ground and the confrontation ends when this occurs or when the trainer (drill sergeant) calls a halt to the contest.

Rifle/bayonet training involves several days of exercises (spread out over the entire training cycle) that entail overcoming opponents through the use of an unloaded rifle and/or a bayonet attached to the rifle. Early in training, trainees practice rifle/bayonet movements on

static dummies. Later in training, trainees initially walk, then run through a bayonet obstacle course several times. The bayonet obstacle course requires the use of the rifle and bayonet on static and dynamic dummies while moving through a series of obstacles.

Unarmed combat is performed several times during training and is essentially grappling with an opponent without any equipment. The trainee uses throws, simulated punches, and wrestling activities to overcome the opponent.

The confidence/obstacle course is performed several times during training. It involves a series of obstacles that the trainee must pass through. Passing through the various obstacles requires a number of body movements including crawling, climbing, jumping, and twisting. Early in training, the trainees walk through the obstacles; later in training they run the obstacles; finally, they complete the course both individually and in teams for time.

Data analysis

Person-time orofacial injury rates (cases/10 000 person-months) were calculated as: (number of orofacial injuries/number of trainees × number of months) × 10 000. Relative risks were calculated as the orofacial injury rate in phase 1 divided by the rates in phases 2 or 3. Statistical analysis was performed using a chi-squared test for person-time, and relative risk confidence intervals were determined with the Miettinen Tests-Based Limits (31). Phase 1 was considered the 'baseline' period (relative risk = 1.00) and phases 2 and 3 were compared with phase 1.

Results

Table 1 shows the orofacial injury rates during the three phases of the evaluation. Compared with phase 1, phases 2 and 3 had lower orofacial injury rates. Orofacial injury rates in phases 2 and 3 were very similar. When compared with phases 2 and 3 combined, the relative orofacial injury rate in phase 1 was 1.76 times higher (95% confidence interval = 1.17–2.65, $P = 0.006$).

Discussion

The present study suggests that the use of mouthguards for specific events in military basic training can reduce the incidence of orofacial injuries. During the period of time when mouthguards were required for only one training event (pugil stick) the rate of orofacial injuries was substantially higher than when the use of mouthguards was required for several training events (pugil stick training, rifle (M16)/bayonet training, unarmed combat, confidence/obstacle course). Phases 2 and 3, which required the mouthguard for four training events, were more than a year apart but the reduction in injury risk was similar in both periods. This suggests that the effectiveness of the mouthguard program was consistent and relatively long-lasting.

This investigation agrees with those in the field of sports that indicate that mouthguards reduce the risk of orofacial injuries (16, 22, 25–29, 32–36). Our study was the first to indicate that mouthguards might be used for specific occupational activities that involve risk of orofacial injury. In the present study, the overall risk of injury when not wearing a mouthguard was about 1.8 times higher than when a mouthguard was worn. This is in consonance with more recent sport studies that report that mouthguard non-users have risks of orofacial or soft tissue injury that are 1.5–2.4 times higher than mouthguard users (16, 25, 26, 29).

A previous study by Katz et al. (30) reported orofacial injury rates ranging from 3.5 to 8.3 cases/10 000 person-months at three basic training locations. These rates are somewhat higher than that the 3.4 cases/10 000 person-months reported in the present study during phase 1. Part of this difference may be due to the presumed protective effect of wearing the mouthguard for pugil stick training during phase 1. Offsetting this presumed protective effect is the fact that during phase 1, from January 2000 to April 2000, the mouthguards were 'phased in' so that new trainees had them but trainees arriving before January 2000 did not. Another consideration when comparing to the Katz et al. study is that BCT is no longer conducted at the three locations sampled by Katz et al., and the type of training conducted in 1975 (when the Katz et al. data were collected) was probably somewhat different than that currently practiced at Fort Leonard Wood. Finally, the Katz et al. investigation considered injuries on the entire post while the present study considered a more select population attending BCT and OSUT.

The major mouthguard complaints received from trainees and drill sergeants included difficulty talking while the mouthguard was in place, and concerns about mouthguard fit. These can be legitimate complaints about boil-and-bite mouthguards. Custom-made mouthguards, fabricated by a dentist from the cast of a person's teeth, are likely to result in a better fit and more comfort for the wearer. However, fabricating custom-made mouthguards for 80 000 trainees each year (the approximate number of trainees each year at all Army installations conducting basic military training) would be financially and logistically prohibitive. While comfort is an important factor in the acceptance of mouthguards,

Table 1. Orofacial injuries among trainees at Fort Leonard Wood during the three study phases

	Orofacial injury cases (*n*)	Time at risk (person-months)	Orofacial injury rate (cases/10 000 person-months)	Relative risk (phase 1/ phase 2 or phase 3)	Relative risk 95% confidence interval	*P*-value (phase 1 vs phase 2 or phase 3)
Phase 1	82	244 762	3.35	1.00	–	–
Phase 2	14	73 932	1.89	1.77	1.01–3.09	0.045
Phase 3	17	89 226	1.91	1.76	1.05–2.94	0.032

this is less of a concern in the training environments where mouthguards are mandated. Also, the few studies that have examined the effectiveness of custom vs boil-and-bite mouthguards have shown no differences in orofacial injury rates (9, 37–40).

One of the keys to success of the mouthguard program was acceptance by the drill sergeants. This acceptance was crucial because the drill sergeants enforced compliance. The program was designed so that drill sergeants were not burdened with the task of distributing the mouthguards, nor of educating their trainees about the importance of mouth protection. They only had to assure the mouthguards were worn for the specific activities. Drill sergeants accepted this responsibility as they were used to requiring specific safety equipment for other training activities.

Partly as a result of this investigation, the Army Training and Doctrine Command mandated the use of mouthguards in June, 2004. Mouthguards are now issued to all trainees during medical inprocessing at all five Army BCT and OSUT locations. Regulations require the use of mouthguards for pugil stick training, rifle/bayonet training, unarmed combat and confidence/obstacle courses.

Disclaimers

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