Sports Dentistry: Mouthguard Fabrication

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Tulsa women’s basketball player has teeth broken against UConn 2015
First Mouthguard

Reportedly invented in the 1860’s by the Cincinnati Red Stockings player George Wright who played catcher and shortstop. Doug Allison, who played catcher for the Red Stockings, had his mouthpiece saved as a team relic but it was later destroyed in a fire.
Nat S. Fleischer, editor of The Ring magazine, stated that the first rubber mouthpiece was used in 1913 by Ted Kid Lewis, an English boxer, who liked it so well that he continued to use it in spite of the protests filed by opposing managers and boxing commissions. Henceforth, other boxers adopted the mouthpiece, and it is now used universally.

Latex Football Mouthpieces

2. Body contacts can be rough in football. The mouth protector prevents the lips from being cut by the teeth, the teeth from being chipped or knocked out, and by acting as a shock absorber, can prevent serious concussions.

Fig. 1 • Latex mouthpiece in place
As dental professionals, what are the best recommendations that we can make to athletes in preventing oral trauma while participating in sports activities?
Total participation in 1971-2 was 3,960,932. Ten times more boys, 3,666,917, played sports than girls 294,015.

The 2015-16 school year set an all-time high of 7,868,900 that included 3,324,326 girls and 4,544,574 boys.
1971-2016 Athletics Participation Totals in U.S. High Schools
1971-2016 Athletics Participation Totals in U.S. High Schools

Boys
Girls
Total

1971-2
79-80
87-88
95-96
2003-4
2015-16
## NCAA Sports Participation

<table>
<thead>
<tr>
<th>YEAR</th>
<th>1971-72</th>
<th>1994-95</th>
<th>2007-08</th>
<th>2015-16</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEMALE</td>
<td>29,972</td>
<td>105,532</td>
<td>166,728</td>
<td>211,886</td>
</tr>
<tr>
<td>MALE</td>
<td>170,384</td>
<td>189,642</td>
<td>222,838</td>
<td>274,973</td>
</tr>
<tr>
<td>TOTAL</td>
<td>200,356</td>
<td>295,174</td>
<td>389,566</td>
<td>486,859</td>
</tr>
</tbody>
</table>
NCAA and High School Female Participation Levels

2015-16
2007-08
1994-95
1971-72
NCAA
High School
Mouth Protectors and Sports Team Dentists.

Bureau of Health Education and Audiovisual Services, Council on Dental Materials, Instruments, and Equipment.

The most desirable protector, however, is the custom-made mouth protector fabricated by a dentist from a thermoplastic material. With the custom-made protector, the dentist can optimize fit, comfort, and speech as well as tend to any control of form to the special dental requirements of the athlete.

<table>
<thead>
<tr>
<th>Author</th>
<th>Country</th>
<th>Percentage of Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilder, et al.(2015)</td>
<td>Georgia</td>
<td>85.2% maxillary central incisors</td>
</tr>
<tr>
<td>Zhang Y, et al.(2014)</td>
<td>China</td>
<td>≈ 85% permanent maxillary incisors</td>
</tr>
<tr>
<td>Choi, et al.(2010)</td>
<td>South Korea</td>
<td>upper primary central incisors most affected teeth(72.6%), maxillary permanent centrals affected 56.4%</td>
</tr>
<tr>
<td>Livny, et al.(2010)</td>
<td>Palestine</td>
<td>89% of affected teeth were upper central incisors</td>
</tr>
<tr>
<td>Thelen, et. al.(2010)</td>
<td>Albania</td>
<td>73.9% of dental trauma to maxillary central incisors</td>
</tr>
<tr>
<td>Altun, et al.(2009)</td>
<td>Turkey</td>
<td>88.2% of dental trauma to maxillary central incisors</td>
</tr>
<tr>
<td>Cetinbas, et al.(2008)</td>
<td>Turkey</td>
<td>84% sports accidents involve maxillary central incisor</td>
</tr>
<tr>
<td>Fakhruddin, et al.(2008)</td>
<td>Canada</td>
<td>70.4% of dental trauma to upper central incisors</td>
</tr>
<tr>
<td>Baldava, et al.(2007)</td>
<td>India</td>
<td>77% of trauma to maxillary central incisors</td>
</tr>
<tr>
<td>Soriano, et al.(2007)</td>
<td>Brazil</td>
<td>81.8% of trauma to upper central incisors</td>
</tr>
</tbody>
</table>
The Advantages of Mouthguards

- Protection of the teeth
- Protection of intraoral structures
- Prevention of jaw fractures
- Reduce the risk of concussion
- Reduction of other head and neck injuries
- Increase the athletes’ confidence
- Replace prosthetic devices
- Promote interaction between dentists and athletes

Characteristics of an Ideal Mouthguard Material

Guevara P, Ranalli D.
*Dent Clin N Am*
• Soft and comfortable, but firm enough to cushion traumatic impact.
• Adaptable to both hard and soft tissues of the mouth and cause no irritation or interference with the movements of the tongue.
• Fabricated with minimum amount of chair time, lab time, and equipment.
• Adaptable over dental replacement appliances in the mouth.
• Retains form even after prolonged replacement and removal from the mouth.
• Modified easily to offer external protection to the lips and nasal area.
• Does not interfere with speech or breathing.
• Does not deteriorate even after prolonged use.
• Does not have an offensive odor or taste.
• Is nontoxic.
Mouthguard Materials

Ethylene Vinyl Acetate (EVA)
Polyolefin
Polystyrene Polyolefin Copolymer
Mouthguard Materials
Ethylene Vinyl Acetate (EVA)
Polyolefin
Mouthguard Materials

• Stock(Type 1) - polyethylene

• Mouth-formed(Type 2) - polyethylene, polyvinyl acetate, polyvinyl chloride shell with ethyl methacrylate powder and liquid mix, vinyl shell acrylic, ethylene vinyl acetate.

• Custom(Type 3) – rubber, vinyl laminate, polyurethane and rubber, silicone rubber, urethane rubber, acrylic, thermoplastic vinyl, polyvinyl acetate, PVA and polyethylene
Materials Studies


Materials Studies


Mouthguard retention: is design or accuracy of fit more critical?

CONCLUSIONS:
The results indicate that mouthguard retention is closely related to the accuracy of fit at the cervical undercut area rather than the outline location.

Thickness and stiffness characteristics of custom-made mouthguard materials

CONCLUSION:
These results show that vacuum-formed mouthguards produced smaller thicknesses than the pressure-laminated mouthguards. The pressure-laminated mouthguards produced material thicknesses that were previously shown to be adequate to protect athletes from trauma.

Waked EJ, Caputo AA. *Quintessence Int* 2005 Jun;36(6):462-6
Vacuum vs Pressure Formed Mouthguards

Vacuum machines provide one atmosphere of pressure
Pressure machines provide 6 atmospheres of pressure
Vacuform
Erkopress 300 Tp™/Tp-ci™
Drufoamat Scan
Pressure Machine

- Built-in barcode scanner automatically programs material heat and cooling time
- Vertical forming design
- Two-handed operation results in safer operation
- Space for lead pellets
- Available through DENTSPLY Raintree Essix 1-800-883-8733
Digital Biostar
## Comparison of Pressure Form Systems

<table>
<thead>
<tr>
<th></th>
<th>Erkopress ci motion</th>
<th>Denshine</th>
<th>Drufomat</th>
<th>BioStar Scan</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MSRP</strong></td>
<td>$3,950</td>
<td>$1,200</td>
<td>$4,599</td>
<td>$4,150</td>
</tr>
<tr>
<td><strong>Pressure Former</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Requires Compressor</strong></td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Digital Control</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>46 lbs</td>
<td>16.0 kg</td>
<td>44 lbs</td>
<td>42 lbs</td>
</tr>
<tr>
<td><strong>Website</strong></td>
<td>glidewelldental.com</td>
<td>alibaba.com</td>
<td>essix.com</td>
<td>greatlakesortho.com</td>
</tr>
<tr>
<td><strong>Model contact</strong></td>
<td>cool side</td>
<td>cool side</td>
<td>cool side</td>
<td>heated side</td>
</tr>
<tr>
<td><strong>Manufacturer site</strong></td>
<td>Germany</td>
<td>China</td>
<td>Germany</td>
<td>New York</td>
</tr>
<tr>
<td><strong>Work pressure</strong></td>
<td>6 bars</td>
<td>2-5 bars</td>
<td>6 bars</td>
<td>6 bars</td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td>12.6&quot;X13.8&quot;X20&quot;</td>
<td>40 cm X 30 X 22 cm</td>
<td>18.1&quot;X11.4&quot;X11.4&quot;</td>
<td>18&quot;X10&quot;X10.25&quot;</td>
</tr>
</tbody>
</table>
Impression and Working Model
Common Mistakes
Common Mistakes
Common Mistakes
Common Mistakes
Common Mistakes
Common Mistakes
Common Mistakes
Common Mistakes
Block out ortho brackets and wires
Stone can be used to block out the brackets
Allowances should be made for erupting teeth
Effectiveness and Fabrication of Mouthguards

- Is the mouthguard effective for preventing or reducing traumatic incidents during sporting events?
- Which type of mouthguard is most effective?
- How can we fabricate properly fitted mouthguards?
- Are mouthguards effective for concussions?
- Are there any side effects of mouthguards?
- How can we promote mouthguard usage among athletes?

Heating Element

Mouthguard Material

Model
Heating Element

Cooler

Hot

Mouthguard Material

Model

“Ideal”
Fabrication of Mouthguards

- Working Model
- Heating and Cooling
- **Required thickness for protection**
- Model height
- Design Labial & Palatal Occlusion
- Orthodontic Patients
- Concussions
- Side effects
- Promotion of mouthguards
Heating Element

2 mm before thermoforming

Mouthguard Material

1 mm after thermoforming

Model
HEAT-PRESSURE LAMINATED

Two Layers

Three Layers
Fabrication of Mouthguards

• Working Model
• Heating and Cooling
• Required thickness for protection
• Model height
• Design Labial & Palatal Occlusion
• Orthodontic Patients
• Concussions
• Side effects
• Promotion of mouthguards
Recreation experts have long recommended the mouth protector as an important piece of safety equipment. Without one, an athlete on the playing field runs the risk of acquiring a toothless grin...

ASK YOUR DENTIST.
Nov 26, 2010   Obama gets 12 stitches after basketball action

After being inadvertently hit with an opposing player's elbow in the lip while playing basketball with friends and family, the President received 12 stitches today administered by the White House Medical Unit. Medical personnel used a smaller filament to close the wound than is typically used, the press office said. That increases the number of stitches but makes a tighter stitch and results in a smaller scar. The president received a local anesthetic during the treatment. The elbow to Obama's lip "happened in the fifth of five games they played.\" The offending player, who remains nameless, "turned into POTUS, who was playing defense, to take a shot when the elbow hit the President in the mouth.\" Some of the players in today's 5 v. 5 game -- "none of whom were responsible for the elbow\" to the president's face--included Obama's nephew Avery Robinson, Obama's assistant Reggie Love and Education Secretary Arne Duncan.